PERSONAL AND COMMUNITY HEALTH

CLAIR ELMER TURNER

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PERSONAL

AND

COMMUNITY HEALTH

By

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THIRD EDITION

ST. LOUIS

THE C. V. MOSBY COMPANY

1931

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Printed in U. S. A.

Press of
The C. V. Mosby Company
St. Louis

TO

MY MOTHER

This book is

Affectionately Dedicated

PREFACE TO THIRD EDITION

The book has been thoroughly revised. Much of the material of the former editions has been omitted and several new sections, including a new chapter on *Health Maintenance,* have been added. Several new illustrations have been introduced. The author wishes to acknowledge the valuable assistance of Frances Sage Bradley, M.D., formerly with the U. S. Children's Bureau, in the work of revision.

C. E. T.

PREFACE TO FIRST EDITION

This book has been prepared for the student at the university, college, normal or professional school. It deals with the health of the individual and with the health of the community, seeking to provide the subject matter background for healthful living and citizenship or for health teaching at the lower levels.

The treatment of personal hygiene presents the facts of healthful living and the scientific principles upon which these health practices rest. There is little discussion of anatomy and the description of body function goes only far enough to make clear the principles of hygiene which are presented.

The public health is considered from the standpoint of what the college or professional man, who is not a sanitarian, needs to know in order to protect his family and meet his responsibility as a citizen.

In arranging the order of the text, those aspects of personal hygiene that are not related to infection are first considered. Then follows a discussion of the development of the new

science of disease prevention and its effect upon personal hygiene and upon public or community health.

The author desires to acknowledge gratefully the assistance received from many persons in the criticism of the manuscript. In particular, thanks are due to Professor Percy G. Stiles of the Harvard Medical School for reading some of the manuscript on personal hygiene and for assisting in the preparation of a diagram of the autonomic nervous system. Special thanks are also due to Dr. F. H. Slack for reading the chapter on immunity, to Dr. F. A. Woods for suggestions in connection with the material on heredity, to Dr. A. LeRoy Johnson for assistance in the chapter on oral hygiene, and to other teaching associates for stimulating and helpful suggestions. The discussion of dental hygiene presented in this book is, in the main, the work of Dr. William Rice, Dean Tufts College Dental School.

The author also wishes to express appreciation to Professor C. E. A. Winslow for permission to use Figs. 1, 2, 10, and 37 from *Healthy Living,* to Dr. Lawrence Baker for permission to use Figs. 7 and 8 from one of his unpublished researches, and to the many others who have assisted in securing illustrative material.

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CONTENTS

PART ONE: PERSONAL HEALTH

CHAPTER I

HEALTH VALUES

PAGE

Health Values—College and University Attitude—Health as a Means—Health Defined—Habits and Health—Health Evaluation and Development—Health Scale—Health and Personality—Nature's Health and Beauty Score Card _ _ _ 17

CHAPTER II

THE HYGIENE OF NUTRITION

Divisions of Personal Hygiene—Diet—Water—Nitrogenous Foods—Carbohydrates—Fats—Inorganic Salts—Vitamins—Balanced Diet—The Varied Diet—Digestion—Digestion and the Emotions—The Hygiene of the Emotions—Mastication—Water with Meals—Rest after Eating—Assimilation—Assimilation Defined—Oxidation—Eliminating the Body Wastes—Autointoxication—Constipation—Food Poisoning—Obesity—Undereating—Conclusions _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 30

CHAPTER III

THE HYGIENE OF THE MOUTH

Development and Function—The Form and Arrangement of the Teeth—Development—Function—Deforming Habits—Structure of the Teeth—The Saliva—Oral Prophylaxis—Caries—Diet in Relation to Decay—Prophylactic Treatment—Daily Care of the Teeth—Method of Brushing the Teeth—Care of the Brush—Dental Floss—Toothpicks—Mouth Washes, Tooth Powders and Pastes—Tooth Cleansing Foods—Care of the Mouths of Children—Septic Teeth as a Source of Systemic Disease _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 56

CHAPTER IV

THE HYGIENE OF ACTION

Two Kinds of Bodily Activity—Exercise—What Exercise Does for the Body—Types of Physical Exercise—Rhythm in Exer-

PAGE

cise—Walking—Ordinary Body Activities—Figure—Round Shoulders—Carrying the Head Forward—Spinal Curvatures —Deformities of the Feet—Sight and Hearing—Breathing—Speaking—Bathing—Clothing—Disorders of the Skin _ _ _ 80

CHAPTER V

THE HYGIENE OF THE CENTRAL NERVOUS SYSTEM

Function—Concentration—Habit—Sleep—Dreams — Change of Work—Sunday Observance—Neurasthenia—Overwork—Emotions—Bodily Defects—Stimulants _ _ _ _ _ _ _ _ _ 101

CHAPTER VI

THE HYGIENE OF REPRODUCTION

The Problem Defined—Heredity—Mendelian Inheritance—How Sex in Offspring is Determined—Sex-Linked Characters—Inherited Diseases and Abnormalities—Mentality and Heredity —Feeble-mindedness—Heredity and Conduct—Prenatal Care —Standards for Maternity Care—Infant Care—The Infant and the Preschool Child—Sex Hygiene—Sex Education—Summary—The Child's Ten Commandments to Parents _ _ _ 113

CHAPTER VII

HEALTH MAINTENANCE

Heart Disease—Diseases of the Blood Vessels—Cancer—Nephritis (Bright's Disease)—Diabetes—Endocrine Disorders—Hay Fever—Asthma _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 142

PART TWO: COMMUNITY HEALTH

CHAPTER VIII

THE SCIENCE OF DISEASE PREVENTION

Early Theories of Disease—Foreshadowing of the Present Theory —Fermentation and Disease—Pasteur—Lister—Koch and the Development of Bacteriology—Preventive Medicine—Smallpox and Vaccination—Immunity in Anthrax and Rabies—Diphtheria and Antitoxin—Preventive Sanitation—The Epidemic of the Broad Street Well—A Typhoid Fever Epidemic from

PAGE

Oysters—Preventive Hygiene—Resistance—Modern Health Services—The Child Health Center—Community Health Centers—The Pay Clinic—Other Organized Health Services—Summary _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 152

CHAPTER IX

COMMUNICABLE DISEASES

The Interrelationship of Plants and Animals—Organisms Which Cause Disease—The Alimentary Diseases—Inoculation Diseases—Mosquito-Borne Diseases—Mosquito Control—Other Insect-Borne Diseases—Respiratory Diseases—Contact Diseases—Summary _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 175

CHAPTER X

ESSENTIAL FACTS OF IMMUNITY

Immunity Defined—Nonspecific Immunity—Fatigue—Exposure to Wet and Cold—Drugs—Malnutrition—Physical Defects—Specific Immunity—Natural Immunity—Local Immunity—Acquired Immunity—Active and Passive Immunity—Carriers—Disease Reactions—Toxins—Endotoxins—Reactive Phenomena—Phagocytosis—Anaphylaxis—Specific Substances—Theories of Immunity—Exhaustion Theory—Retention Theory—Phagocytic Theory—Side Chain Theory—The Bacteriophage _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 191

CHAPTER XI

THREE GREAT PLAGUES

Three Great Plagues—Tuberculosis—Prevalence—The Difficulties—Transmission of Tuberculosis—Prevention and Control—Syphilis—Importance—Nature of the Disease—Transmission—Immunity — Prevention — Educational Program — Other Venereal Diseases—Common Cold—The Cause of Colds—Catching Cold _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 212

CHAPTER XII

FOOD CONTROL

Food Adulteration—Cost of Adulteration—Nature and Cause of Adulteration—Pure Food Laws—Misbranding—Law Enforce-

PAGE

ment—Food Sanitation—Milk—Graded Milk—Remade Milk—Condensed, Evaporated and Dried Milks—Meat—Dangers in Meat—Prepared Food _ _ _ _ _ _ _ _ _ _ _ _ _ 232

CHAPTER XIII

WATER SUPPLY

What is Good Water—Sources of Water Supply—Water Analysis—Environment—Bacteriological Study—Physical Tests—Chemical Tests—Nitrogen and the Nitrogen Cycle—Chlorine—Microscopic Analysis—Water Purification—Storage—Filtration—Chlorination—Emergency Treatment of Drinking Water 248

CHAPTER XIV

WASTE DISPOSAL

Sewage Disposal—Direct Disposal—Chemical Purification—Bacteriological Purification—Aerobic Processes—Anaerobic Processes—Final Disinfection—Possibilities and Limitations of Sewage Purification—Rural Sanitation—Disposal of Garbage—Disposal of Manure _ _ _ _ _ _ _ _ _ _ _ _ 265

CHAPTER XV

PUBLIC HEALTH ADMINISTRATION

Public Health Authority—Federal Public Health Functions—The Power to Regulate Commerce—Taxation—Defense and Welfare Powers—Treaty and War Powers—The U. S. Public Health Service—Other Federal Health Agencies—State Health Functions—Public Health Laws—State Health Administration—Administrative Functions—Local Health Administration—Authority—Local Health Organization—County Health Unit—The Health Officer—Unofficial Health Activities _ _ _ _ 285

CHAPTER XVI

SCHOOL HYGIENE

The Problem—The School Health Program—Sanitation of the School Plant—The Prevention and Eradication of Disease—Personnel—Communicable Disease Control—Physical Examination—Mental Examinations—The Examining Room—The Correction of Defects—Defective Vision—Defective Hearing—

PAGE

The Dental Care of School Children—Medical Service—Special Groups of Defectives—Special Health Classes—Health Promotion—Health Education—Physical Education—Standards _ 305

CHAPTER XVII

INDUSTRIAL HYGIENE

General Problems—Hours of Work—Fatigue—Child Labor—Women in Industry—Factory Inspection—Industrial Accident Insurance—Health Administration in Industry—Accident Prevention—Industrial Sanitation—Food—Medical Activities—Industrial Dentistry—Disease Prevention and Health Education—Industrial Diseases—Tuberculosis—Lead Poisoning—Phosphorus Poisoning—Mercury Poisoning—Benzene Compounds—Other Industrial Poisons—Protection against Industrial Poison _ _ _ _ _ _ _ _ _ _ _ _ 337

CHAPTER XVIII

VENTILATION, HEATING AND LIGHTING

Good Air Defined—Temperature—Moisture—Odors—Testing Air—The Sling Psychrometer—The Hygrodeik—The Polymeter—The Comfort Meter—Ventilation and Heating—Natural Ventilation—Artificial or Mechanical Ventilation—The Importance of Moisture—Air Washing and Humidifying—Cooling Air—The Economic Value of Good Ventilation—Lighting _ 358

APPENDIX A

THE CONTROL OF COMMUNICABLE DISEASES

Definitions—The American Public Health Association Committee Report upon: Actinomycosis—Acute Infectious Conjunctivitis—Ankylostomiasis (Hookworm)—Anthrax—Chickenpox—Cholera—Dengue—Diphtheria—Dysentery (Amebic)—Dysentery (Bacillary)—Epidemic (Lethargic) Encephalitis—Favus—German Measles—Glanders—Gonorrhea—Influenza—Leprosy—Malaria—Malta Fever—Measles—Meningococcus Meningitis—Mumps—Paratyphoid Fever—Plague—Pneumonia (Acute lobar)—Poliomyelitis—Rabies—Rocky Mountain Spotted or Tick Fever—Scabies—Scarlet Fever—Septic Sore Throat—

PAGE

Smallpox—Syphilis — Tetanus — Trachoma — Trichinosis—Tuberculosis (Pulmonary)—Tuberculosis (Other Than Pulmonary)—Tularemia—Typhoid Fever—Typhus Fever—Whooping Cough—Yellow Fever _ _ _ _ _ _ _ _ _ _ 374

APPENDIX B

DISINFECTION AND DISINFECTANTS

Definitions--Disinfection versus Sterilization—Antiseptics—Deodorants—Fumigation—Disinfection—Control of Disinfection—Natural Disinfection—The Ideal Disinfectant—Standardizing Disinfectants—Physical Agents of Disinfection—Gaseous Disinfection—Formaldehyde Gas—Sulphur Dioxide—Oxygen—Hydrocyanic Acid—Liquid Disinfectants—Mercuric Chloride—Formalin—Potassium Permanganate—Lime—Whitewash—Milk of Lime _ _ _ _ _ _ _ _ _ _ _ _ _ 421

BIBLIOGRAPHY _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 431

ILLUSTRATIONS

FIG.		PAGE
1.	The composition of cow's milk	41
2.	Portions of different foods each yielding approximately 100 calories of heat energy	42
3.	Diagram showing the most important distributions of the autonomic nervous system	49
4.	The worry-autointoxication cycle	52
5.	Model illustrating normal occlusion	57
6.	Model illustrating normal occlusion	58
7.	Asymmetric development of the bones of the skull of a dog	59
8.	Upper aspect of the skull shown in Fig. 7	60
9.	Deformity from lack of function	61
10.	Air passages of the mouth and nose showing their relationship to the adenoids and tonsils	62
11.	Deformity due to thumb sucking	63
12.	Diagram illustrating groups of fibers of the gingivæ and peridental membrane	64
13.	Deformity resulting from neglect of the teeth	67
14.	Showing malocclusion due to caries	68
15.	Diagram illustrating nomenclature of gingivæ	70
16.	Diagram illustrating nomenclature of gingivæ	70
17.	Dental hygienists in Prophylactic Clinic at Forsyth Dental Infirmary for Children	72
18.	Toothbrushes of proper shape and material	75
19.	Good and bad postures	86
20.	Posture chart showing the result of the examination of Harvard freshmen	87
21.	Semidiagrammatic drawing of a section of the skin	97
22.	Animal parasites	99
23.	Graph showing the relation between sleep and factory output	106
24.	Inheritance in guinea pig showing where one color dominates over another color	114
25.	Diagram illustrating the mechanism by which the unit factor, color, is inherited in guinea pigs	116
26.	Eminent twins	117
27.	Transmission of color blindness	120
28.	Taking the blood pressure	144
29.	Diagnostic skin tests for hay fever	151

FIG. PAGE

30. Cholera deaths in the epidemic of the Broad Street Well _ 164
31. Whipple's chart showing modes of infection in typhoid fever and the barriers against its spread _ _ _ _ _ _ _ 180
32. Life history of a malaria parasite _ _ _ _ _ _ _ _ _ 183
33. Life history of the mosquito _ _ _ _ _ _ _ _ _ _ _ 185
34. Diagram illustrating the three orders of immunity as described in Ehrlich's Side Chain Theory of Immunity _ _ 208
35. Comparative figures showing the number of disease and battle deaths each year per thousand troops in the wars of the United States _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 213
36. The relative proportion of army deaths caused by the principal diseases in the war with Germany _ _ _ _ _ _ 214
37. An inexpensive and easily constructed outdoor sleeping porch 220
38. Chart showing the time and temperatures at which bacteria are killed and at which the quality of the milk is changed 237
39. Modern plant for the pasteurization of milk _ _ _ _ _ _ 241
40. Pollution of wells by water which soaks through the soil from privies or cesspools _ _ _ _ _ _ _ _ _ _ _ _ _ 251
41. The nitrogen cycle _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 254
42. Diagram showing the condition of the stream studied at Brockton _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 259
43. Diagram showing the abundance of microorganisms at the various sampling stations _ _ _ _ _ _ _ _ _ _ _ 260
44. Shows how completely the higher aquatic plants fill part of stream in summer _ _ _ _ _ _ _ _ _ _ _ _ _ _ 261
45. Showing how differently the same region appears under winter conditions and high-stream flow _ _ _ _ _ _ 261
46. A chemical closet installed in a home where running water is not available _ _ _ _ _ _ _ _ _ _ _ _ _ _ 267
47. Removing the sludge from the sand beds at the Brockton Sewage Purification Works _ _ _ _ _ _ _ _ _ _ _ 269
48. Imhoff tank _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 274
49. Sewage purification plant in Atlanta, Ga. _ _ _ _ _ _ 277
50. A single-seated sanitary privy _ _ _ _ _ _ _ _ _ _ 279
51. Rear view of privy _ _ _ _ _ _ _ _ _ _ _ _ _ _ 280
52. Outdoor incinerator (Arnold type) _ _ _ _ _ _ _ _ 282
53. Life history of the house fly _ _ _ _ _ _ _ _ _ _ 283
54. Floor plan and arrangement of medical inspector's room generally followed in New York City _ _ _ _ _ _ _ 318

FIG. PAGE

55. The effect of treatment for adenoids upon the general appearance of three children _ _ _ _ _ _ _ _ _ _ _ _ _ 320
56. Errors in refraction _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 321
57. Giving hearing test by means of the audiometer _ _ _ _ 323
58. Dental Clinic at the Forsyth Dental Infirmary for Children 325
59. Wet and dry bulb thermometer _ _ _ _ _ _ _ _ _ _ _ 362
60. Sling psychrometer _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 363
61. Hygrodeik instrument _ _ _ _ _ _ _ _ _ _ _ _ _ _ 364
62. Portable foot candlemeter _ _ _ _ _ _ _ _ _ _ _ _ 373

Fifty years ago the slogan for health was *mens sana in corpore sano*— . . . . Nowadays we know only too well that the sound mind and the sound body are unavailing for the conduct of normal living unless the environment with which they have to deal consists of fairly good air, fairly pure water, fairly good food, and is fairly free from communicable diseases, unfavorable temperatures, defective ventilation, dirt, noise and other prejudicial sanitary conditions.

—Sedgwick.

PART I
PERSONAL HEALTH

CHAPTER I

HEALTH VALUES

Your health depends, not upon what you know, but upon what you do.

What does health mean to you? How important is health in your present habit of life, and how important will it be in carrying out your plans for the future? Is it a means in itself or is it a means to another end? In either case how important is it? Would you sacrifice health for other aims, or should other things in life be sacrificed for it?

Have you ever enumerated the things which you would like to be, to do, to acquire—in other words, the important things you hope life holds in store for you, and then made a candid evaluation of the importance of health in relation to these matters. Do you know where you stand at present in the matter of your own health, and to what extent your habits of living are affected by it? These questions concerning your attitude toward health and the regulation of your daily life in reference to health are important.

To learn facts regarding the health of individuals or communities is an educational, perhaps a cultural process, but unless your habits of life and the quality of your citizenship are improved thereby you have missed the greater part of the educational opportunity. What is your attitude toward health, your evaluation of it, and your daily program in relation to it? When a university group expresses its opinion of health values in either discussion or writing, the evaluation is usually sound, but habits of life are often formed without the application of a reasoning process.

Health Values.—Theodore Roosevelt once wrote to his son, "I want you to do well in your sports, and I want even more that you should do well in your books, but I do not expect you to stand first in either, if so to stand would break you down and injure your health." This at first seems like strange advice from that great President who was an apostle of hard work and a strenuous life. Mr. Roosevelt would never urge laziness or low ambition. Nor was he the man to put health above everything else. His was the spirit which would lay down health and even life itself for his country or his friend.

The persistence with which he developed his own young stripling body into that of an exceptionally vigorous and effective man bears witness to the value he placed upon physical fitness, and to the genuineness with which he practiced what he preached. He regarded health as being more important than any temporary or transient success which is not really significant or particularly beneficial. Do you agree with his appraisal or have you developed a philosophy of making any health sacrifice, of putting any unreasonable demand upon your body for the attainment of an immediate success? Or what is equally serious, have you laid out your daily program without regard to your physical improvement?

College and University Attitude.—The history of student attitude regarding this point has not been altogether a proud one. The sight of a student leaving college for lack of health or graduating in wretched physical condition has been altogether too common. It may be that the breakdown came in part as the result of inherited weakness. But if there were physical limitations the student should have learned of them from a physical examination at college entrance and followed a life program within these limitations, either by a less strenuous course in college with particular attention to health improvement, or by entrance into some other field of activity. By far the more common cause of such a breakdown is a misuse of the body from following a program so

neglectful of physical welfare that health cannot be maintained. A college or professional education would hardly seem worth while if it brought with it physical incapacitation for the intended lifework even though we disregard the suffering and unhappiness of the individual. But these people who break down completely are few in comparison with the number who are half well and drag themselves about in the gray haze of depression with only a fraction of the enjoyment which life could afford them.

Our problem is one of relative values. It is apparent from discussions of personal health with many college and professional school students, that the man or woman in abundant good health has usually given little thought to its importance, his eyes are fixed on other goals, and it is only when he takes time to consider the relationship of health with these ambitions that he forms a normal estimate. On the other hand, the man who is struggling against ill health invariably looks to health as a goal, and places an exceedingly high value upon it. The sick regard the degree to which health can be attained as a measure of the enjoyment of life. They say "Health is the most important thing," and that "life without health is hardly worth while." Those who have the least health value it most. This variation in evaluation comes from the difficulty of man to appreciate what he has always possessed. Contrast sharpens vision. Things lost take on new values.

Health as a Means.—Health is obviously not the ultimate aim of life. There are more important things. Honor, integrity, justice, manhood, womanhood, have been maintained at cost of human life. Every man has a normal ambition to do or to perform an important and useful service in life. This ambition may be worthy of a sacrifice of health, but certainly sacrificing health does not in itself accomplish the ambition. In fact it usually defeats it.

The scheduled programs of our national military and naval academies have come nearer giving the proper emphasis to

the physical side of life. Here the student anticipates a definite type of service and responsibility. It is recognized that he cannot equip himself for the service or accept the responsibility without a good body, and the daily program of each man is so planned as to give particular attention to bodily health.

Health Defined.—One reason for the false attitude toward health has been a misunderstanding of what health really is. Some one has said that health can be determined only by a study of "the total person at work over a period of time." It is the normal functioning of all parts of the body, but most people have divided the sick from the well according to whether the body is horizontal or perpendicular to the surface of the earth. In other words, if you were so ill as to be confined to bed people said you were "sick," otherwise you were "well." But the number of really well people among those who are "up and about" is relatively small. Health is much more than merely not being "sick in bed." Normal functioning of all parts of the body means joyousness, cheerfulnss, and efficiency, as well as the ability to do a full day's work without more than a healthful fatigue. It means courage and enthusiasm for life. We need to build into our definition for health these ideals which we express by the term *complete physical fitness.*

Habits and Health.—Physical fitness demands freedom from defects in the organs of the body, but it is maintained only through a normal regimen of healthful living. There is ample evidence of the effect of habits of life upon health. In the tuberculosis sanatorium the frail, malnourished, pretubercular child—not by medication but by proper food and rest and an ideal environment—is made over into a sound and robust youngster. The training schedule for college athletes and the regular life of the military training camp have repeatedly produced transformations in the physical powers of individuals. Nutrition studies have demonstrated the relationship between a properly arranged diet and

health. Physiologic investigations have shown that the emotions and the mental states affect the body. If you will watch carefully your own physical condition, for a period of two weeks and note the varying efficiency with which you are able to undertake mental and physical tasks seeking each time for the cause of the fluctuation noted, you can see how your habits of eating, sleeping, working, resting and playing are related to accomplishment.

Faulty habits of living of the people at large is one of the most important factors working against the national health and efficiency. The examination for the draft army showed thousands of defects which might not have developed under proper habits of living. Every health department is confronted with the spread of communicable disease because of faulty hygiene. The private practitioner of medicine, the hospital or clinic can point out to you case after case of nervous breakdown, of organic or degenerative disease of middle life which came as a result of faulty habits. The occasional contrast of a long and busy life made possible by a good heredity plus proper habits of living only intensifies our conviction that such habits are generally lacking.

Perhaps more than we realize we are affected by inherited religious attitudes, by the conceptions of the Old Testament, which regard disease as sent by the hand of God, and maintain that we should accept our "afflictions" as part of the divine plan. Such a philosophy is dangerously comfortable in relieving the individual of health responsibility. We disown the philosophy promptly enough when confronted with it and perhaps the woman who has ruined her arches by improper shoes does not even know the origin of her false attitude when she voices the excuse that "the Lord gave me weak arches and I suppose I always will have trouble with my feet."

Modern civilization has developed a strenuous competitive community life which places a premium upon mental rather than upon physical labor. The struggle for social and mate-

rial progress crowds out consideration of our physical well-being, and we fail to maintain buoyant health. But this failure comes from lack of knowledge as well as from changing conditions of life. The great body of important facts in both personal hygiene and communicable disease control has developed within the last thirty years; indeed, much of it within a shorter period. There has been as yet no opportunity for this information to find its way into the lives of the great mass of our people.

Sanitation has nearly eliminated many of the diseases which spread by an intermediate host or substance. Preventive medicine and medical practice are making constant advances, but we are confronted by a group of both communicable and organic diseases which will be conquered only by the development of positive personal health and effective community action.

Health Evaluation and Development.—It is not extremely difficult to evaluate the health of an individual or to lay down the important rules for healthful living. The most common failure in carrying out a health schedule comes from individual carelessness or a failure to place a proper evaluation upon health. If each member of a college or university class in hygiene were asked to submit as complete a list of daily health habits as possible without referring to literature on the subject, it is quite certain that all of the important rules would be mentioned at least once somewhere in the lists. If the merits of each rule submitted were debated in the class and a vote taken as to its value, it is also probable that a very satisfactory and correct set of standards would result from this class discussion without exhaustive reference to expert opinion. A student very commonly fails to check himself up and see where he stands in relation to health, and in the past he has very generally failed to use the hygienic information which he possesses in laying out his daily schedule.

The following health scale prepared by Dr. Thomas D. Wood of Columbia University provides a scheme for grading your own health based upon bodily conditions and habits of living.

Health Scale*

Personal health and efficiency involve certain subjective and objective factors and evidences.

I. Subjective.

- a. Enjoyment and zest in work and play. 3
- b. Feeling of being rested and refreshed in morning and not more than wholesomely tired at bedtime. 3
- c. General attitude of cheerfulness and confidence in relation to life. 3
- d. Freedom from *persistent* worry and anxiety. 3
- e. Freedom from regularly recurring or persisting physical pain and discomfort. 3

II. Objective factors and evidences of health.

- a. Hygienic daily regimen.
  1. Ability to work with comfort and satisfaction eight hours a day, five and a half, or six days in the week. (44-48 hours a week.) 3
  2. Eating regularly three balanced meals daily. Drinking at least four glasses of water daily outside of meals. 4
  3. Giving eight to nine hours in bed, and to sleep, daily. 4
  4. Lying down and resting ten to twenty minutes between 11 A.M. and 2 P.M. each working day. 2

*Blanks for recording individual scores may be obtained in quantity from Dr. Thomas D. Wood, Teachers' College, Columbia University, New York City.

5. Devoting one-half to one hour daily to vigorous physical exercise outdoors, in gymnasium or swimming pool (at least three hours exercise a week outdoors). Exercise should be vigorous enough to cause deep breathing. 3

6. Devoting one to two hours daily (in addition to daily exercise) to social recreation or recreative reading, or other recreative occupation. 3

7. At least one satisfactory bowel movement daily, with regular attention to this function. 3

8. Brushing teeth at least twice daily in approved way. 2

9. Daily tonic bath and skin friction of type suitable for the individual. 2

b. Keeping one full day each week for rest from regular work. 3

c. Using at least two evenings or afternoons a week, in addition to the seventh day, for non-professional activity. (Occasional use of one or both of these evenings or half-day periods, for professional activity, might be justified in an emergency.) 3

d. Keeping weight within standard range for health, not more than 10 per cent below nor 15 per cent above standard for age and height. 3

e. Dressing hygienically. 3

1. Clothing protecting against sudden changes in temperature.

2. Shoes sensible in shape, guarding against marked changes in height of heels.

f. Freedom from metabolic errors (evidenced by urinalysis) and other less obvious defects

which are only revealed by regular, thorough physical examination. 3

g. Freedom from remediable health handicaps and defects including:
   1. Heart defects. 3
   2. Lung defects. 3
   3. Defective posture. 3
   4. Defective teeth. 3
   5. Eye defects. 3
   6. Defects of ears and hearing. 3
   7. Diseased tonsils. 3
   8. Defective nutrition. 3
   9. Skin disorders. 3
   10. Weak arches. 3
   11. Visceroptosis. 5
   12. Muscle flabbiness, etc. 3

h. Freedom from susceptibility to those diseases for which specific immunity is practically obtainable by vaccination—Smallpox, Typhoid, Diphtheria. 3

i. Freedom from susceptibility to those infections (e.g., colds) which result from unhygienic habits of living and remediable health handicaps. 3

100

Health and Personality.—There is another factor in the maintenance of proper habits of living. In addition to their effect upon the body itself, they affect the personality, the impression produced by the individual upon other people, and therefore his success. The realization that one's mode of living is in some respects lower than that to be expected of a cultured and intelligent man makes one ill at ease, like the wearing of clothes which are not suitable for the occasion. Conversely, proper habits not only produce physical and mental efficiency, but also confidence in meeting people. Students of the elements which go to make up personality

recognize this. In a recent number of a popular magazine Dr. W. W. Charters* of the University of Pittsburg, Professor of Education and Director of Research in Methods of Training Men and Women for Administrative Positions, lists the following twenty qualities the presence or absence of which determines one's strength of personality: Ambition, industriousness, persistence and patience, dependability, forcefulness, effectiveness of speech, self-confidence, friendliness, adaptability, tact, cheerfulness, good judgment, sensitiveness to criticism, ability to size up people, memory, neatness, health habits, discrimination, economy, capacity to delegate work. Referring to health habits he says, "This is not a matter of your *endowment* of physical health. Severe illness may not mean that you are short in this trait. Ask yourself whether your *habits* are those that make for or against good health, and how they tell on your working ability and mental attitude day by day."

A somewhat different viewpoint is brought out by a consideration of the relationship between personal hygiene and personal attractiveness. People in business, professions and society, are continually making first impressions. The quality of this impression may be largely determined by one's attention to personal health. This is shown by the following score card, prepared for women students by Miss Mary Preston of the State Teachers' College of San Francisco, and reprinted here in modified form by the courtesy of the American Child Health Association from their booklet entitled "My Health Book."

NATURE'S HEALTH AND BEAUTY SCORE CARD

Are you as attractive as Nature intended you to be? Score yourself.

Score Points	
20	(a) *Average weight for age and height*†
5	(b) *Hair* Clean, glossy, free from oil, and becomingly dressed

*"Personality—Its Twenty Factors and How You Can Develop Them," by Dr. W. W. Charters, *The American Magazine.*

†The weight is usually regarded as satisfactory if within 10 per cent below or 15 per cent above average.

5 (c) *Eyes*
2 Shining and alert; not dull and heavy
1 Not strained; no puckery lines or frowns
2 Clear white of eye; not muddy or yellow

5 (d) *Mouth*
2 Happy expression
3 No mouth breathing

5 (e) *Teeth*
3 Well cared for
2 Good apposition (teeth meet properly)

10 (f) *Skin*
2 Clear
2 Good color
1 Smooth
2 Tissue firm
2 Skin under eyes smooth and clear
1 Cheeks and lips natural color

5 (g) *Hands*
2 Immaculately clean
1 Skin smooth
2 Nails and cuticle clean and carefully cared for (no extremes)

10 (h) *Feet*
5 Normal; inner border of bare foot a straight line from heel to end of big toe (big toe not bent toward other toes by pointed shoes, as this is apt to lead to a prominent joint at base of big toe). All toes able to spread apart
5 Feet properly shod (no extremes); straight inner border, low broad heels, flexible shank. (This does not apply to evening shoes.)

10 (i) *Posture while standing*
1 Head well poised
1 Shoulders level (one shoulder not lower than the other)
1 Arms relaxed
1 Body line unbroken by abdomen; chest broad
1 Feet in good position; slightly apart and parallel

Good lines and grace while seated

1 Lower spine against chair-back
1 Hands in repose; knees almost touching each other; feet parallel or one crossed over the other

Harmony of movement while walking

1 Good rhythm of entire body
1 Feet toeing straight ahead
1 Elastic step; firm, not heavy

5 (j) *Good hearing*
Able to hear ordinary conversation at 16 feet

5 (k) *Good vision*
Able to read ordinary print at arm's length without strain

10 (l) *Health as a social asset*
- 5 Radiating good health and spirits (full of enthusiasm)
- 3 Poise (perfect self-control; inspiring others with confidence)
- 2 Voice well placed and round; not high, thin or nasal

5 (m) *Clothing*
- Adapted in line and color to the individual; suitable to season and occasion

100 *Total*
- Is your score what you would like it to be? If not, why not look first to your diet and then follow the eight Rules of the Game?

As a student you master mathematics, history, biology or what not because you recognize the need of that knowledge in the pursuit of your prospective career. The need for hygiene arises from the fact that we do not often find ourselves in an ideal environment. Life is a process of continually adapting, fitting, adjusting oneself to surroundings. Your body is your own. Its health, its obedience to your will are passports for the voyage through life. Formerly institutions of learning placed high mental achievement as the ultimate goal of attainment. The modern college and university realize that it is no longer enough to train intellectual pedants. Rather would they produce scholarly, vigorous men, alert and responsive to the needs of a moving world.

Whatever else may be expected of the college or professional man and woman, it would seem reasonable to expect the advantages of a higher education to have equipped them with both the knowledge and the habits for a healthful program of living. The technical knowledge required for an appreciation of the fundamental rules of hygiene is not extensive. Healthful living is not restricted to those who have had an opportunity for extensive study in physiology, valuable as such a study certainly is. In fact, in health habits as in ethics, there is no direct correlation between how much a man knows, and how well he acts. The facts of hygiene presented in this book may be expanded greatly

when introduced into the classroom, and yet the most complete knowledge from a textbook or lecture will not improve your health, your physical efficiency, your attractiveness, or your personality.

Good health is a state of complete physical efficiency. It is developed by habit, by custom, by doing, and not by merely thinking, or wishing, or knowing.

CHAPTER II

THE HYGIENE OF NUTRITION

Hygiene or the science of healthful living furnishes to man the basis for a rational control over those habits and conditions of existence which affect for good or ill the smooth and normal operation of the body mechanism. The development of healthful habits of life depends primarily upon the individual, but the maintenance of healthful living conditions is largely beyond individual control, and the responsibility rests upon organized society. In the restricted sense hygiene considers the health of the individual, sanitation the control of the environment.

In considering the hygiene of the body as a whole there are two distinct sets of problems: (1) the proper development and normal functioning of the parts and (2) the problems arising because of environmental dangers. The first seven chapters of this book deal more particularly with the first-mentioned subject. Subsequent chapters deal with the second group of problems and with special phases of hygiene and sanitation as related to community life.

The Divisions of Personal Hygiene.—Personal hygiene as contrasted with public hygiene or public health considers those principles and activities for the promotion of health over which the individual has control, and to determine the scope of this science we have to consider the functions of man as an animal. In simple language nature has decreed that man shall eat, work, think, and reproduce. The zoologist expresses this idea more elegantly and scientifically by saying that the particular functions of animals are assimilation, action, sensation, and reproduction. Accepting either set of terms in their broad sense we may group the problems of personal hygiene under these four heads:

1. Hygiene of Nutrition.
2. Hygiene of Action.
3. Hygiene of the Central Nervous System.
4. Hygiene of Reproduction.

The process of keeping the body in a properly nourished condition is complex. It demands the consumption of suitable foods in proper quantities, adequate digestion, the transmission of these digested foods to the parts of the body where they are finally used, the burning of the fuel foods, the rebuilding or growth of the tissue, and the elimination of the waste products of cell activity. The Hygiene of Nutrition may be divided into the problems of (1) diet, (2) digestion, and (3) assimilation.

1. DIET

Many people worry about how to get the foods they like, but few think much about choosing the foods which the body demands. Indeed if one led an active and normal life and could choose freely among the foods he likes, he could, to a large extent, rely upon his natural taste to select the proper diet. To select a diet scientifically or to know where the unscientific method breaks down, however, we must understand the nutritional needs of the body.

These dietary needs may best be understood by studying the products of digestion which finally pass through the walls of the stomach and intestines. Were you able to accomplish the gastronomic feat of sampling every product exhibited at a food fair, there would be from all this food but six types of digestive products finally reaching the body tissue. To explain: if we regard the body as a tube within a tube, as we properly may, then the material in the digestive tract is not in the body proper; it is merely in contact with the "inner skin" and may only reach the body by penetrating the intestinal wall. Such penetration is accomplished by only six kinds of substances: (1) water, (2) amino acids, (3) simple sugars,

(4) products of fat digestion, (5) inorganic salts, and (6) vitamins. What is the use of each of these food materials in the body? Why and how must we provide a diet which will insure the proper amount of each?

Water makes up two-thirds of the body weight and in active tissues like muscle it is three-fourths the total weight. Moreover, the body has a liquid carrier system. The blood and lymph, which are mainly water, carry food to the tissues and remove from them the waste products of combustion. The chief way of eliminating waste nitrogen from the body is by means of the water passing through the kidneys. Every individual knows that in making thirst more painful than hunger nature makes a constant and insistent demand for water in the diet.

So important is the activity of water that we might almost speak of a distinct water circulation consisting of the passage of water from the diet into the body and its elimination from the lungs in the form of moisture, from the skin in the form of sweat, and through the kidneys in the form of urine. The amount of water excreted in these ways by an active man in the course of a day amounts to over two quarts. Nevertheless, we find that a deficiency of water in the diet, especially among people engaged in a sedentary occupation, is a most common and serious fault.

Water may be obtained in the diet in a variety of ways. The greatest quantity of course, is obtained through drinking water and other beverages, like tea and coffee, but much also is obtained from the solid food. This is notably the case with fruits and vegetables many of which contain over 90 per cent of water. Watermelon is 98 per cent water. Soup and broth are also sources of water supply in the diet. The amount of water necessary for proper waste elimination and for feeding the tissues in an individual of average weight is four or five pints per day. Of this, at least six glasses should be drunk in the form of water itself.

Nitrogenous Foods.—The chemically simple products of protein digestion are the amino acids. They are the substances from which new tissue is built up in the growing body, and from which worn-out tissue is replaced in the adult. These compounds are sometimes called the building stones of tissue substance because they recombine on the other side of the intestinal wall and in the various parts of the body to form the typical body proteins. These substances, chemically of simple molecule, contain carbon as well as nitrogen and may therefore undergo partial oxidation. They are to a certain extent fuel foods, since part of the molecule is oxidized to supply heat and energy. The chemical formula of one of the simplest amino acids, glycocoll, is CH_2NH_2COOH. Other amino acids are of larger molecule.

The protein foods in most common use are meat, fish, milk and eggs, although much nitrogen is to be found in the lentils, peas and beans, and in such wheat products as bread, and macaroni. Enough of this type of food is required to supply nourishment for growing or wasted tissue but it has usually been found that where man is free to choose his diet to a considerable extent there is an excess rather than a deficiency of protein. Only in India has a characteristic protein deficiency been found and here the effects among the members of the lower classes, where meat and fish are rare articles of diet, include a lessened physical vitality and a dwarfed stature. Where protein is taken in excess the carbon and hydrogen portion is used as fuel food and the excess of nitrogen is excreted through the kidneys in the form of urea. The office and professional worker often places a heavy burden on the kidneys by making them excrete a large amount of nitrogen in only a small amount of water.

Carbohydrates.—The carbohydrates (sugars and starches) are compounds of carbon, hydrogen and oxygen in which hydrogen and oxygen are present in the same ratio as in water. They are admirable fuel or energy producing foods because when they are oxidized or burned in the body they are

completely broken down into carbon dioxide and water, both of which are easily eliminated waste products.

Digestion reduces all sugars and starches to simple sugars of the $C_6H_{12}O_6$ type such as dextrose (glucose or grape sugar) and these are the digestive products which pass through the walls of the alimentary canal. The absorption of sugars is rapid and begins in the stomach. For this reason simple sugars supply the body with fuel very promptly. This may in part explain why eating sweets a short time before meals takes away the appetite. However, the strong flavor of sugar or sweets which makes other foods taste flat and insipid is a more potent factor.

Sugar is the form in which carbohydrate is transported and used in the body while starch (glycogen) is the storage form. The blood usually contains from 0.06 to 0.1 per cent sugar and a reserve supply is kept in the liver as glycogen or animal starch. The body is free to draw upon this reserve when more energy is needed so that the amount of sugar in the blood may be increased when fear, anger or other emotions press the body for vigorous action. After the sugar content of the blood rises to 0.2 or 0.3 per cent glycosuria (the presence of sugar in urine) appears. For a man doing physical work especially in the cold where heat is lost rapidly a large carbohydrate diet is essential and under these conditions it is natural for the individual to increase the relative amount of carbohydrates consumed. A man in a sedentary occupation does not require so large a quantity of this type of food.

Fats.—The third type of food passes the walls of the alimentary canal in the form of soap, glycerine, and fatty acids. The fats or hydrocarbons also contain the elements of carbon, hydrogen, and oxygen but the proportion of oxygen is less than in sugars and starches. Consequently they may be regarded as fuel foods in a more concentrated form since the same weight requires more oxygen for combustion and therefore is of greater heat value. Fat is a good reserve food since large quantities may be stored in the adipose tissues.

To a large extent it is interchangeable in the diet with sugars and starches. The production of large quantities of butter fat by the cow, which subsists upon a protein and carbohydrate diet, is an excellent demonstration of the ability of the animal body to synthesize fats from these other types of food.

Inorganic Salts.—The fourth group of body foods contains inorganic salts of sodium, calcium, potassium, sulphur, iron, and phosphorus. The salts of calcium are important in forming the hard structure of bone and the dentin of the teeth. The chlorine of common salt is used in the production of hydrochloric acid for gastric digestion. Iron, sulphur, and phosphorus are important constituents of the more vital tissues. Red blood corpuscles contain a large amount of iron; they are constantly breaking down and must be replaced.

These salts are obtained in organic or inorganic form but are most readily usable in the body when secured as organic salts from plant and animal structures. There is at present a tendency among physicians to prescribe the salts needed by the body in the organic form in which they are found in foods rather than in the inorganic form as they are frequently combined in drugs. Most proteins are found associated with some of these minerals. Lettuce is particularly rich in potassium. Calcium is very abundant in milk. Phosphorus is plentiful in meats and egg yolk. With the exception of iron the salts in milk (as found in the ash) correspond not with those in the blood but with the ash obtained from the whole young animal. Iron is very plentiful in meat, yolk of egg and in spinach, apples and asparagus. Iodine, needed especially in goitrous sections, is found in oatmeal, salmon, and in certain edible sea weeds, such as Irish moss.

Children during the period of growth need a wise excess of mineral elements. Up to the age of thirteen years the child should receive in some form the equivalent of a full quart of milk daily to take care of the calcium and phosphorous requirements. Part of this can be supplied in the form of vegetables or other foods, but in this regard it must

be remembered that not all foods are useful. Cereal foods, grains, fats, meat, are all poor in calcium. Grain products do, however, contain considerable amounts of phosphorus.

The importance of calcium in the diet of the expectant mother is especially great. She must have enough not only for her own requirements but also for the bones and teeth of the developing embryo. Sound teeth can be laid down only if adequate calcium, phosphorus, and vitamins are supplied through the diet of the mother. Lack of these mineral elements in infancy predisposes to rickets.

Vitamins.—These substances constitute a group other than fats, proteins, salts or carbohydrates, yet essential to growth and well-being. They occur in the body only in minute quantities, but their deficiency causes grave conditions and their protective qualities serve so beneficent a purpose as to justify a careful study of their source and behavior in the human economy.

Vitamin A is important to the adult in relation to his general well-being. It is essential to the young child for the promotion of growth and for its protective powers against certain infectious diseases. Its absence causes xerophthalmia, a disease which is common in the Orient. It has occurred in Europe and occasionally in the United States among babies fed largely on skimmed milk and oatmeal or barley gruel. It is characterized by failure of the tear glands to function, followed by dryness, bacterial growth, and ulceration of the cornea. It may be prevented by giving the child an adequate amount of foods containing vitamin A. These foods are whole milk, cream, butter, and egg yolk, practically all leafy vegetables, and such yellow vegetables as carrots, sweet potatoes, and yellow corn. Vitamin A abounds in such animal organs as liver, kidneys, and sweetbreads.

This vitamin is called "fat-soluble" because it may be held in solution by animal fats, though not to any appreciable extent by vegetable oils, such as olive, peanut, or cottonseed oil. It oxidizes readily on prolonged exposure to

heat and air. Ordinary cooking does not materially diminish its potency.

Vitamin B has been called an antineuritic substance because of its beneficent effect on certain nervous disorders. What was originally thought to be a single vitamin is now known to consist of at least two elements so different in their characteristics and behavior as to justify separate discussion. For the time being they are known as B_1 and B_2 or as some authorities call them F and G. Apparently it is a deficiency of vitamin B_1 that causes *beri-beri.*

This disease is found in Asia among the people who make polished rice a large part of their diet. It is characterized by progressive emaciation, loss of weight and of strength. There is neuritis, the inflammation of the nerve trunks being followed by degeneration resulting in prostration and frequently in death. This disease has been induced experimentally by feeding birds upon polished rice. The birds showed a typical polyneuritis with inactivity, loss of weight, and muscular contraction. But when fed with an aqueous extract of rice bran the birds immediately recovered. In the same manner the disease among human subjects has been stamped out by using unpolished rice or by introducing a mixed diet.

A deficiency of B_2 is probably responsible for the development of *pellagra,* originally a disease of the East though during the past generation, it has been found in the United States, especially in mill sections of the South. Like beriberi it was considered a dietary disease and, for a time, all foods containing cottonseed meal or oil were condemned—with futile results. The elimination of corn products proved equally unsatisfactory. Then came the suggestion of a possible infective complication, for it was noted that the disease appeared in successive families living in a given house. At the same time it was observed that, when treated in the early stages, the disease yielded promptly to a generous diet of milk, eggs, meat, and fruit, and vegetables which contain vitamin B. These results were obtained among workers

whose diets lacked sufficient fresh food and similarly when the disease occurred in homes of the well-to-do where a capricious appetite proved as disastrous as limited means or intelligence.

There seems at present some doubt as to the wisdom of calling pellagra a true deficiency disease. Sherman *(American Journal of Public Health,* 1929) finds sufficient grounds for returning to the theory of a possible infectious invasion of a body depleted and nonresistant.

The onset of the disease is marked by pigmentation or bronzing, especially of the flexor surfaces of hands and arms, and by sore mouth with gastric disturbance. In neglected cases the bronzing becomes a flaming erythema and the tongue becomes raw. The gastric irritation increases and there is distressing diarrhea with prostration.

There seems scant reason for deficiency of a substance so widely distributed as vitamin B. It is found in fresh fruits, roots and tubers, in leafy vegetables, peas and beans, in cereals, and in such glandular organs as liver, kidneys, and sweetbreads. Vitamin B is "water-soluble" and, while relatively heat labile, it loses little of its value in ordinary cooking unless soda is added. It will even stand canning if done by the modern cold pack method.

Vitamin C prevents scurvy. This disease, which is produced by a lack of fresh foods in the diet, was a common disease upon ships in the days before it was possible for them to carry a larder stocked with fresh, canned, or cold storage vegetables and meat. It has now largely disappeared. The introduction of the potato was an important factor in driving the scourge from Europe, by increasing the quantity of fresh vegetables eaten.

For many years this was considered a strictly deficiency disease but, according to Rosenau, cases occurring during the World War suggested the complication of an infection superimposed upon a debilitated state. The patient loses color, weight, and strength. The ankles become swollen and

tender, the gums bleed readily, and there may be hemorrhages in other soft tissues, leaving purple splotches. Early cases respond to a liberal diet of foods containing vitamin C.

This is the most unstable of all vitamins. Milk, in the process of sterilization or even of pasteurization, loses its normal content of vitamin C. This must be restored by giving foods rich in this substance, or the bottle-fed infant may develop scurvy. Vitamin C exists in milk, in citrous and other fruits, and in vegetables that can be eaten raw, such as tomatoes, carrots, celery, cabbage, and the like. While it is unstable in the presence of prolonged heat and air, tomatoes and other vegetables may be acceptably canned if kept under a weak salt solution while in the course of preparation, then processed by the cold pack rather than by the old open method.

Vitamin D, which is antirachitic, is "fat-soluble" and has the distinction of being the only vitamin as yet synthetically prepared from a definite chemical compound. Authorities in the United States and Europe claim that from 80 per cent to 90 per cent of young children suffer from rickets. It usually appears during the early months of life, attacking preferably the premature, the artificially fed, and even the rapidly-growing breast-fed baby. He becomes restless, wakeful, constipated, and there is profuse sweating, especially of the head. Later the head enlarges and becomes misshapen. Knobs or beads (the so-called rosary) appear at the junction of ribs and costal cartilages. Similar knobbing occurs at ends of long bones, giving enlarged wrists, ankles, and knees (knock-knees). The long bones of the legs may not be equal to the task of supporting the weight of the baby. They curve, giving the child bowlegs. The thorax may seem flattened on the sides, and the sternum depressed or protruding, giving the typical pigeon breast. Muscles and ligaments seem too lax to hold the body together. The child sags, grows pot-bellied, hollow-chested and round-shoul-

dered—becomes the child of poor posture. He is slow in teething, slow in walking, slow in developing.

Children living in the arctics where fish and fish-eating animals constitute the chief diet seem immune to this disease. These foods contain ergosterol, the active element in vitamin D. Children of the tropics also seem protected by virtue of the irradiation of the sun's rays on their bare bodies. The successful preventive treatment of rickets should begin within the first month of life by adding to a properly modified diet, daily doses of cod liver oil (rich in ergosterol), and by exposing the child's body to the direct rays of the sun under a doctor's direction. The mother also needs special medical care during pregnancy if she would protect her child from this disease. Vitamin D is found sparingly in butter fat, egg yolk, and fish.

Vitamin E is associated with reproduction. Certain diets have been found upon which young rats can grow to maturity but upon which they cannot produce young. Such a diet may be made to contain all of the other known vitamins and yet the animals reared upon it are sterile. If the oil of wheat, cottonseed, corn, soy beans, peanuts, or olives is added to the diet, sterility no longer persists. It seems unlikely that deficiency of this vitamin is of any importance in determining sterility in humans, because of the distribution of the vitamin in food which people generally use.

Balanced Diet.—Proper nutrition not only demands that these six kinds of foods be secured but that they be secured in proper proportions. This proportion may be judged roughly from the composition of milk which is the perfect food prepared by nature for young infants. Human milk contains approximately 2½% protein, 3½% fat, 6½% sugar and 0.25% inorganic salt. We find therefore that water makes 86% of the infant's diet. Vitamins are also present in mother's milk but as in any diet in analytically negligible quantities.

The quantity of the three important types of food which are necessary for a normal individual has usually been computed on the basis of the number of calories necessary for the individual. A calorie is the amount of heat required to raise a kilogram of water one degree centigrade. It is possible to measure the energy output of the body in calories and to determine the heat energy in the same way. Each gram of protein, fat, and carbohydrate material when oxidized yields respectively 4.1, 9.3 and 4.1 calories.

Fig. 1.—The composition of cow's milk. The bottles are arranged from left to right to show the actual amounts of water, sugar, fat, protein and ash in a quart of milk.

It is found that the energy requirement varies according to the age and size of the individual and the amount of physical work performed. The child needs relatively more protein food than the adult because new tissue is being produced. Murlin points out that ice cream represents the proper proportions for adults since it is milk plus sugar and fat, the protein being

diluted. The child also needs relatively more fuel food for the work done because the small body has more surface to the unit weight and the amount of food required varies more directly with the surface of the body than with the weight of the body. Heat loss depends upon extent of body surface.

Men doing muscular work usually secure 3,500 calories or more in their daily ration. People of sedentary occupation

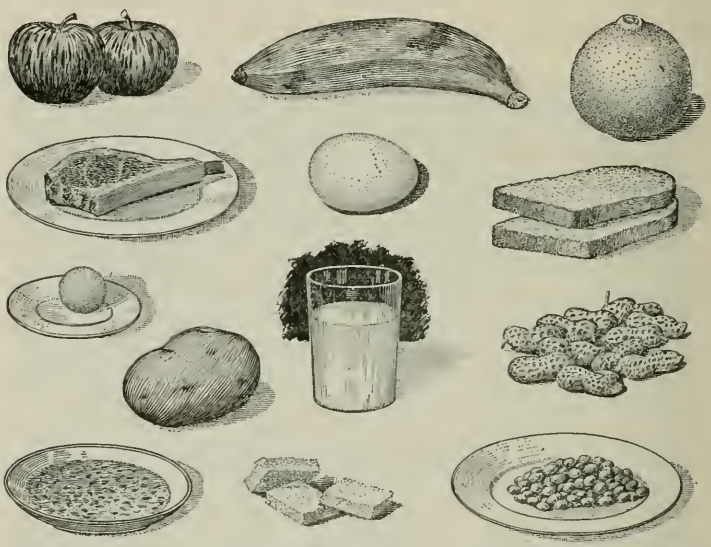


Fig. 2.—Portions of different foods each yielding approximately 100 calories of heat energy. They include: an ordinary serving of beans, 3 large lumps of sugar, 1 large banana, 11 double peanuts, 1 large egg, 1 potato, 1 chop, 2 slices of bread, 1 orange, 2 apples, ⅔ of a glass of milk, 1 pat of butter, and an average serving of oatmeal.

find something less than 2,500 to be sufficient. The following table taken from Stiles' *Human Physiology* gives a suitable average food combination for the sedentary individual:

Protein	75 grams or	300 calories
Fat	50 grams or	465 calories
Carbohydrate	375 grams or	1500 calories
Total		2265 calories*

*For practice in computing the calorie content of his own diet the student is referred to tables in "Feeding the Family" by Rose.

Another way to estimate the food requirement in protein, carbohydrates, and fat would be to state the amount of some well-known food necessary to provide a sufficient quantity of each. If all the protein in the day's diet were to be secured from lean beefsteak, all the fat from butter, and all of the carbohydrate from rice the individual would need to eat approximately the following quantities of these foods in order to secure the gram or caloric requirement mentioned above:

Beefsteak	⅘ lb. (375 gr.)
Butter	⅛ lb. (59 gr.)
Rice	1 lb. (475 gr.)

The Varied Diet.—The whole tendency of recent dietary study has been to show that variety in diet is necessary. A variety of proteins is desirable because each protein is made up of a different combination of amino acids, which we have called the building blocks; and in order to be sure to include in the food all of the amino acids needed by the body many different proteins should be eaten. Again we have seen that fresh vegetables, leafy tissues, meats and natural fats contain "vitamin" substances which are little known chemically but which are necessary for a proper balancing of the diet.

Furthermore, man must choose a reasonable amount of hard foods in order to exercise the jaw and preserve the teeth. A certain amount of bulk must also be secured to furnish a stimulus for peristalsis in the intestines and maintain the normal activity of the bowels. This is secured by eating fruit, vegetables and other bulky foods poor in nutritive value.

2. DIGESTION

Digestion is a complicated process. Certain factors—mechanical, physiological, chemical, psychological—enter into its adequate completion.

The mechanical action of good, sound teeth plays an important part in refining the food for digestion. The tongue

and muscles of the stomach and intestines, by repeated dilatation and contraction, churn, mold, and move along the properly prepared contents, thus subjecting them to the various digestive juices. Normal vigor and tone of these muscles must therefore be preserved if we would avoid a slowing down, a clogging of the intestinal tract.

Digestive juices containing certain physiological elements called enzymes play an important part in the digestive process. The enzymes secreted by the salivary glands and by those of the intestinal tract act only in an alkaline medium, while those of the gastric glands function only in the presence of an acid.

The salivary enzymes begin the digestion of sugars and starches, which is completed in the intestines. The gastric enzymes start the digestion of proteins, milk, eggs and meat, which likewise is completed when in contact with intestinal juices. These juices begin and complete the digestion of fats. Food thus broken down and changed into an assimilable state is ready for absorption, the more concentrated portion from the small intestine and more dilute fluids from the large intestine.

Good digestion is something more than the mere swallowing of the proper number of grams of the various kinds of food each day. To get the best results the food must be appetizing, the person must be in the proper mental state, the food must be eaten in suitable fashion, and bodily activities must not seriously interfere with digestion.

Digestion and the Emotions.—The work of Dr. Cannon upon the emotions has shown us clearly the importance of proper psychic conditions in normal digestion. Nowhere else is there such a good statement of the facts at hand. Commenting upon the previous work of Pawlow with dogs Cannon says:

> By the use of careful surgical methods he was able to make a side pouch of a part of the stomach, the cavity of which was wholly separate from the main cavity in which the food was received. This pouch was

supplied in a normal manner with nerves and blood vessels and as it opened to the surface of the body, the amount and character of the gastric juice secreted by it under various conditions could be accurately determined. * * * In some of the animals thus operated upon an opening was also made in the esophagus so that when the food was swallowed, it did not pass to the stomach but dropped out on the way. All the pleasures of eating were thus experienced, and there was no necessity of stopping because of a sense of fullness. This process was called "sham feeding." The well-being of these animals was carefully attended to, they lived the normal life of dogs, and in the course of months and years became the pets of the laboratory.

By means of sham feeding Pawlow showed that the chewing and swallowing of food which the dogs relished resulted, after a delay of about five minutes, in a flow of natural gastric juice from the side pouch of the stomach—a flow which persisted as long as the dog chewed and swallowed the food, and continued for some time after eating ceased. Evidently the presence of food in the stomach is not a prime condition for gastric secretion. And since the flow occurred only when the dogs had an appetite, and the material presented to them was agreeable, the conclusion was justified that this was a true psychic secretion.

Other experiments upon dogs have shown that merely the sight or smell of a favorite food will start the pouring out of the gastric juice. Analogy teaches us that good cookery not only makes our mouth water but it makes our stomachs water as well. This initial psychic secretion of gastric juice is important because the continuance of its flow during digestion is brought about by the reaction of its acid or digestive products upon the mucous membrane of the duodenum.

The saliva produced when the mouth waters not only starts the digestion of starches but it also assists in enabling us to taste our food, for materials are tasted only when they are dissolved.

To quote further from Dr. Cannon's excellent description:

The conditions favorable to proper digestion are wholly abolished when unpleasant feelings such as vexation and worry, or great emotion such as anger and fear, are allowed to prevail. This fact, so far as the salivary secretion is concerned, has long been known. The dry mouth of the anxious person called upon to speak in public is a common instance; and the "ordeal of rice," as employed in India, was a practical utilization of the knowledge that excitement is capable of inhibiting the

salivary flow. When several persons were suspected of crime, the consecrated rice was given to them all to chew, and after a short time it was spit out upon the leaf of the sacred fig tree. If anyone ejected it dry, that was taken as proof that fear of being discovered had stopped the secretion, and consequently he was adjudged guilty.

What has long been recognized as true of the secretion of saliva has been proved true also of the secretion of gastric juice. For example, Hornborg was able to confirm in his little patient with a gastric fistula the observation by Pawlow that when hunger is present the mere seeing of food results in a flow of gastric juice. Hornborg explained the difference between his and Pawlow's results by the different ways in which the boy and the dogs faced the situation. When food was shown, but withheld, the hungry dogs were all eagerness to secure it, and the juice very soon began to flow. The boy, on the contrary, became vexed when he could not eat at once, and began to cry; then no secretion appeared. Bogen also has reported the instance of a child with closed esophagus and gastric fistula, who sometimes fell into such a passion in consequence of vain hoping for food that the giving of food, after the child was calmed, was not followed by any flow of the secretion. * * *

The studies of Bickel and Sasaki confirm and define more precisely this inhibitory effect of strong emotion on gastric secretion. They observed the inhibition on a dog with an esophageal fistula, and with a side pouch of the stomach, which, as in Pawlow's experiments, opened only to the exterior. In this dog Bickel and Sasaki noted, as Pawlow had, that sham feeding was attended by a copious flow of gastric juice, a true psychic secretion, resulting from the pleasurable taste of the food. In a typical instance the sham feeding lasted five minutes, and the secretion continued for twenty minutes, during which time 66.7 cubic centimeters of pure gastric juice were produced.

On another day a cat was brought into the presence of the dog, whereupon the dog flew into a great fury. The cat was soon removed, and the dog pacified. Now the dog was again given the sham feeding for five minutes. In spite of the fact that the animal was hungry and ate eagerly, there was no secretion worthy of mention. During a period of twenty minutes, corresponding to the previous observation, only 9 cubic centimeters of acid fluid were produced, and this was rich in mucus. * * *

On another occasion Bickel and Sasaki started a gastric secretion in the dog by sham feeding, and when the flow of gastric juice had reached a certain height, the dog was infuriated for five minutes by the presence of a cat. During the next fifteen minutes there appeared only a few drops of a very mucous secretion. * * *

Recently Oechsler has reported that in such psychic disturbances, as were shown by Bickel and Sasaki to be accompanied by suppressed secretion of the gastric juice, the secretion of pancreatic juice may be stopped, and the flow of bile definitely checked. All the means of bringing about chemical changes in the food may be thus temporarily abolished.

Dr. Cannon describes most interestingly his own experiments which show that the excitement in pain, fear and rage also prevent the normal contractions of the stomach and intestines.

Even indications of slight anxiety may be attended by complete absence of the churning waves. In a vigorous young male cat I have watched the stomach for more than an hour by means of Roentgen rays, and during that time not the slightest beginning of peristaltic activity appeared; yet the only visible indication of excitement in the animal was a continued quick twitching of the tail to and fro.

Physicians who treat great numbers of digestive disorders frequently receive a clinical history of indigestion with symptoms of heaviness in the stomach after eating, as though the food failed to pass on to the intestines. Such a case exhibits an increasingly aggravated condition. This type of nervous or *emotional indigestion* in specific cases has been shown to be definitely related to unfavorable mental states. The accompanying diagram shows the way in which the autonomic nervous system reaches and affects the various parts of the body.

It should be added here that the secretion of adrenalin and the increase of the sugar content of the blood are important and complicating factors. Not only is digestion completely inhibited by the stronger emotions but the blood and muscles are supplied with more fuel and the circulatory and nervous systems are toned up to enable man to exert his utmost physical strength as he was usually called upon to do during his more primitive existence and during the long period of evolution.

The Hygiene of the Emotions.—Certain conclusions inevitably follow. Digestion ensues much more readily if the food

eaten is appealing in sight, odor and taste. Among people who, because of illness or for some other reason have a dainty appetite special care in these particulars is very important. It is also clear that the forced feeding of children, the unnecessary punishment of children at the table, and feeding immediately after the child has been in a passion are all unhygienic. Among adults it is equally important that the meal should be pleasant and free from anxiety, worry and ill-feeling. Otherwise a vicious cycle will be set up and the man who begins by worrying at his meals or thinking intensely upon the problems of his work will set up a mild indigestion which will in turn lower his efficiency, aggravate his work by depleting his physical condition and initiate him into the unstable and unenviable fraternity of neurasthenics.

"Enjoy your food" is an excellent maxim. Enjoy your meal, the surroundings, the company and the food. Choose food which you will enjoy eating and eat slowly. If food is eaten under proper conditions it is much more likely to be eaten properly.

Mastication.—The digestion of starches and sugars and the preparation of these substances for absorption is begun in the mouth. If these foods are swallowed without proper chewing and the addition of saliva their normal digestion is impossible.

Important beginnings of protein digestion take place in the stomach by the action of the peptic secretion from the walls of the stomach and these are carried further by the action of the pancreatic juice and other fluids. These fluids must act upon the exposed surfaces of foods and therefore if a piece of meat the size of a marble is cut into particles the size of coarse sand by proper chewing, the surface area available for digestive action is increased more than ten times.

Water With Meals.—There has been much discussion about the advisability of drinking quantities of water with the meals. There seems to be no reason why water taken with the meals should be injurious unless it is used to wash down dry

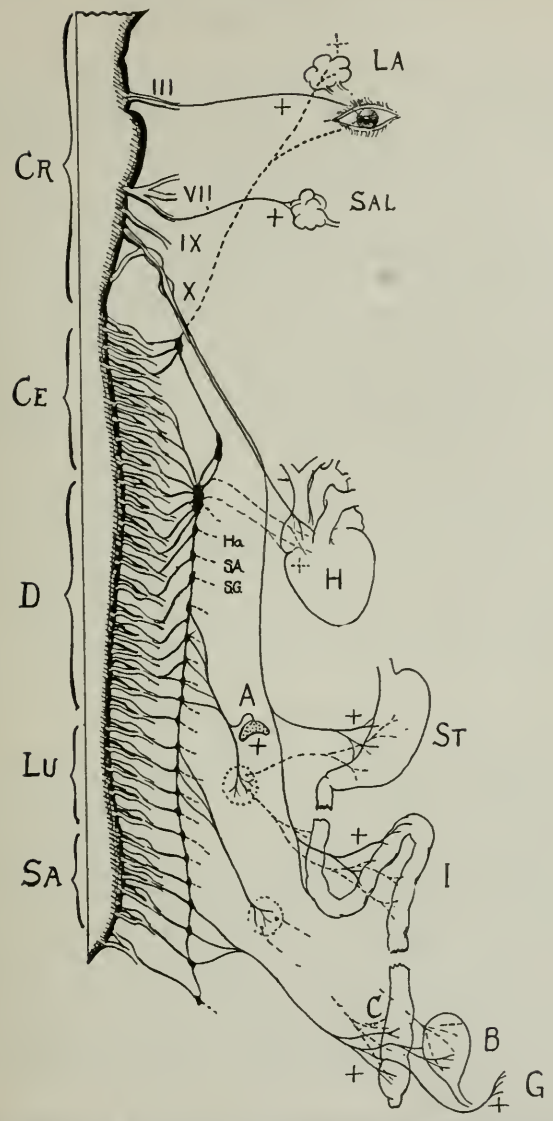


Fig. 3.—Diagram showing the most important distributions of the Autonomic Nervous System. One-half of the brain and spinal cord is represented at the left. The preganglionic fibers of the Autonomic Nervous System are in solid lines; the postganglionic in dash lines. The cranial, cervical, dorsal, lumbar, and sacral divisions of the nervous system are indicated by the letters *Cr, Ce, D, Lu,* and *Sa,* respectively. The organs indicated as affected by the emotions include the lachrymal glands, the pupils of the eyes, the salivary glands, heart, hair, superficial arteries, sweat glands, adrenal bodies, stomach, intestines, colon, bladder, and genitals. (After Cannon.)

food in order to save the individual the trouble of chewing or unless it is taken at a low temperature and in such quantities as to cool the stomach and slow up the action of the secretive tissues of the stomach wall.

Rest After Eating.—In experiments recorded above Pawlow shows that the secretion of gastric juice lasted for twenty minutes after the end of a five minute period of sham feeding. Bickel has also shown, in the case of a girl with a closed esophagus and gastric fistula, that gastric secretion continued active for some time after eating even when no food had entered the stomach. We have also seen that the effects of the unpleasant emotions and mental states are sufficient to inhibit the secretion of digestive juices after the process is once started. For these reasons and because of the withdrawal of blood from the digestive tract to the muscular organs in the case of hard manual labor we may conclude that an after-lunch rest period, postponing for at least one-half hour the return to active labor, is highly desirable.

3. ASSIMILATION

Assimilation Defined.—The processes of nutrition which take place after the food has been absorbed by the walls of the digestive tract and taken into the circulation are chiefly the functions of the absorption and combustion of the food material in the tissues and the elimination of waste from the body. These processes include the use of oxygen in combustion and the elimination of the chief end products of combustion—water, carbon dioxide and urea. Nitrogen is eliminated through the kidneys, in the form of urea, carbon dioxide through the lungs, and water through the lungs, kidneys and skin.

Oxidation.—Apparently assimilation is not impaired by a lack of oxygen due to poor ventilation. As we shall see in describing ventilation, the injurious effects of poor air are not due to the chemical content of the air but to an entirely

different set of factors. The supplying to the tissues of this all important element depends much more upon proper breathing and suitable exercise. These matters will be considered in more detail under the hygiene of action.

Eliminating the Body Wastes.—The elimination of urea is made easier by limiting the protein diet so as to avoid an excess of nitrogen for elimination by the kidneys and by drinking large quantities of water in order to reduce the concentration of the urine. It has been shown that the action of the kidney in withdrawing the salts of urea from the blood and combining them in a much more concentrated form in the urine involves definite energy consumption.

The evacuation of the bowels is mainly the elimination from the body of substances which have never passed through the walls of the alimentary canal since the secretions which are thrown into the digestive tract constitute but a small part of the feces. But we should not neglect to reaffirm the importance of so regulating the diet and the habits that defecation may be regular in order that the material in the rectum and lower bowel may not become inspissated and absorbed to such an extent that the blood is loaded with these poisonous waste proteins and the vitality of the individual temporarily impaired.

Autointoxication.—We have seen that the emotions may so interfere with digestion that the process is not properly commenced or if underway it is brought to an abrupt stop. When this occurs food may remain in the stomach for many hours instead of being passed on to the intestine. The bacteria, which are always present in the digestive tract in countless numbers, are especially active when digestion and normal absorption is delayed so that the fermentations which they set up in the intestine produce gas and cause pain. Under normal conditions the nitrogenous food is largely absorbed before the material reaches the colon but if digestion has not been sufficiently completed these proteins do reach the large intestines and undergo putrefaction with the consequent pro-

duction of poison which will be absorbed into the blood and produce the ill effects of *autointoxication.*

The signs of beginning or transient autointoxication are drowsiness, inertia, headache and a feeling of fatigue. If it is long persistent nervous depression, hardening of the arteries, anemia, and arthritis may result. The body will recover from a single attack of autointoxication but it may be readily seen that long continued grief or anxiety may produce a chronic condition which in turn would increase the nervous trouble setting up a vicious cycle.

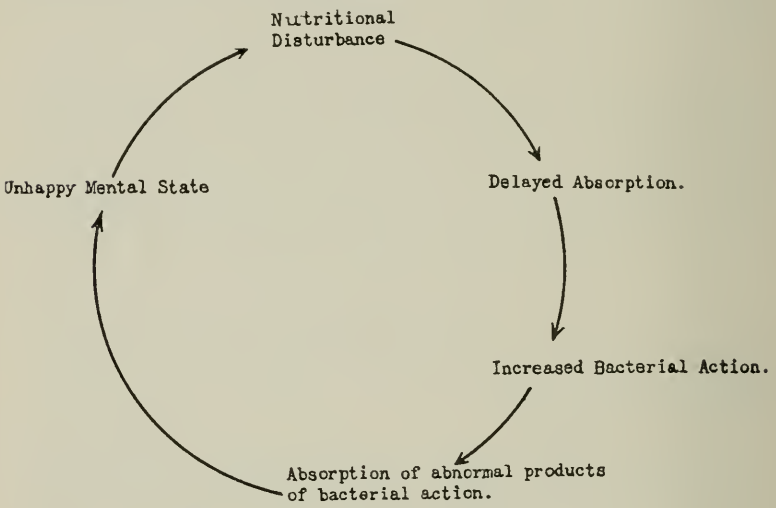


Fig. 4.—The worry-autointoxication cycle.

Overeating as well as the emotions will cause autointoxication and it is possible that the slightly excessive consumption of food may in the long run produce injurious effects. Fortunately for the individual greatly overloading the stomach is likely to be followed by a mild diarrhea. In the case of autointoxication the occasional use of a cathartic is beneficial but it should not be used too often. Moderation and temperance in eating especially in the eating of protein foods is most important. The drinking of sour milk or the regular

ingestion of lactic acid bacteria is a measure aimed to prevent the putrefaction associated with autointoxication by substituting lactic acid fermentation as the dominant type of bacterial action in the alimentary canal.

Constipation or the slow movement of food along the intestinal tract may or may not be associated with autointoxication. Its seriousness is overemphasized in the ever present advertisements for cathartics, but the condition is harmful and should be avoided by the use of plenty of water, by eating "roughage" such as fruit and vegetables and by prescribed exercises. A habit of at least one movement a day at a regular time should be established. The habitual use of cathartics or enemas should not be encouraged.

Food Poisoning.—The newspapers frequently recount cases of "ptomaine poisoning" in which persons suffer from extreme pain, diarrhea, and frequently from forcible vomiting, coupled with a high fever and extreme prostration. Ptomaines are supposed to be poisonous substances produced by the bacterial decomposition of nitrogenous food under certain conditions. It is lately much less common to hear of ptomaine poisoning and many cases which have been so reported have been found upon investigation to be due to bacterial infection. In fact the existence of specific ptomaines is in question. Recent experiments upon the quality of canned foods have completely failed to disclose the presence of ptomaines or other poisons.

Certain people are poisoned by particular foods, such as strawberries, eggs or lobsters. This type of poisoning is hard to understand but it may be a type of anaphylactic reaction as suggested in the chapter on Immunity.

Obesity.—The tendency to become overweight is no doubt constitutional although of course it is true that adipose tissue can only be acquired by the continued consumption of more fuel than is used by the body.

There are two ways to combat overweight, by reducing the amount of food or by increasing the oxidation. When we are

not eating we are losing weight at the rate of about one ounce an hour. Fasting will reduce weight but it is extremely unpleasant. Sometimes drugs are given which destroy one's appetite but they too are likely to be unpleasant and to injure digestion. The oxidation of food may be increased by exercise but, unfortunately for the person who is trying to reduce, exercise is followed by an increased appetite and a greater consumption of food.

The use of a diet high in protein is sometimes recommended. This decreases the amount of food eaten because protein quickly satisfies hunger and also accelerates the process of oxidation. This procedure always places too heavy a burden upon the kidneys; and perhaps a better and more consistent plan is to substitute, in so far as possible, coarse and bulky foods like fruit and vegetables for the fuel foods like sugar, starches and fats. In this way hunger can be satisfied without taking too much nutritive material.

Under-Eating.—Common and bothersome as are the problems of overweight cases of under-eating are perhaps more serious and more frequent. Many people suffer the loss of physical and mental vigor because through carelessness in their eating habits or lack of means, they fail to secure the food that they should have. Women, particularly, often fail to secure suitable and nourishing food because of the expense, the trouble, or the fear of gaining a few pounds. One foolish fad is the no-breakfast hobby. After the longest fast of the twenty-four hours there is something wrong with the stomach that rejects the next meal. The growing child who is unable to eat her breakfast is by the same token in no fit condition to go to school.

The underfed person is in many respects the exact opposite of the individual who is overweight. Such a person drags himself about—underweight, pale, sensitive to cold, morose, querulous, and pessimistic. He sleeps lightly and works without enthusiasm and without surplus energy. The overfed person is perhaps not very diligent but he is

cheerful, optimistic, of ruddy countenance, and a heavy sleeper. To secure the golden mean in diet is greatly to be desired.

CONCLUSIONS

Many factors are involved in the proper regulation of the diet. The protein must be applied in suitable quantity and variety. The quantity of the fuel foods must be adjusted to the kind of work being done. Plenty of water is essential. The necessary inorganic salts must be secured from various sources and vitamin substances must be provided. The emotions must not be allowed to impair the digestion and proper habits of eating should be acquired.

Every person should study himself and learn what foods best agree with him. He should experiment to find the best arrangement for hours and types of meals. In general, men doing mental work find that they can do best when the breakfast and lunch are not too heavy and the hearty meal is eaten at night. Lunch particularly should be light, if work is to be done early in the afternoon. Many but not all people work on a light breakfast. But in all these things personal habits, bodily constitution, and daily schedule are important and although there are some general rules every person must learn what best agrees with him.

CHAPTER III

THE HYGIENE OF THE MOUTH

The subject of Hygiene concerns the health of the body in all its parts and there is no natural division which makes it necessary to consider any particular portion of the body under a separate head; nevertheless there is one part of the digestive tract, the mouth, which deserves special consideration. The recent and widespread recognition of the important rôle played by the teeth in various systemic infections gives to the mouth and its parts a special claim to separate treatment. Are the teeth simply pegs in a row destined to distress mankind in their coming and going, with an interim of aching for good measure, or are they culpable of instigating the many ills attributed to them today? At least, we owe them cleanliness; a knowledge of their structure, development, and function; and an understanding of what part they play in the general economy of the body.

DEVELOPMENT AND FUNCTION

We will consider the means provided by nature for the maintenance of oral health under three headings, as follows:

1. Form and arrangement of the teeth.
2. Structure.
3. Saliva.

1. The Form and Arrangement of the Teeth should be such that their relationship offers the highest degree of correlation; each tooth performs its functions as a dependent unit in a perfect machine operated under the motive power of the muscles of mastication.

The teeth are in four classes, incisors, cuspids, bicuspids and molars, each class designed for a particular function in the process of mastication. The type or form of the teeth in each of these classes varies according to the shape of the face of the individual, as Williams has shown in his classic work. ("Classification of Human Tooth Forms," *Journal of the Allied Dental Societies,* Vol. IX, No. 1.)

When the teeth are in normal alignment each tooth is in actual contact at one point, known as the contact point, with the tooth on each side of it. The object of this contact is to protect the soft tissues between the teeth from the

Fig. 5.—Model illustrating normal occlusion.

crowding of food upon them. Any deviation from normal alignment or the loss of any tooth in the arch (with the possible exception of the third molar), will result in impairment of function and a loss of the protection to the investing tissues; and opportunity will be afforded for the crowding of food material between the teeth, thereby establishing a condition favorable to fermentation and putrefactive changes.

The alveolar process, which is the bony tissue surrounding the roots of the teeth, is a temporary structure designed to

furnish support to the teeth while present within the jaw. It is built up around the roots of the teeth as they develop after the eruption of their crowns and is removed by the process of absorption after the loss of any tooth. It follows, therefore, that after the premature loss of a tooth and the removal of its supporting process, no stimulus remains for bone development; the continuity of the entire arch is broken and the teeth tend to drift in the direction of least resistance. This results inevitably in the loss of the normal relationship between the approximating surfaces of the teeth of each jaw as well as the occlusal relationships of the teeth in opposing jaws. Serious deformity may follow.

Fig. 6.—Model illustrating normal occlusion.

Development.—Let us revert to the period of development. Baker has shown in his researches upon animals that the normal development of the dental arches is dependent upon the presence within the jaw of the developing teeth. The development of the bone is synchronal with the development of the roots of the teeth. The removal of the teeth from one side of the jaw was shown to cause an arrested development of the bone which resulted in marked deformity. The inharmony of the side of the face from which the teeth were removed was very apparent. It was further demonstrated that normal development of the entire bony structure of the head is to a certain extent dependent upon the proper development of the teeth.

Function.—Among the causes of malocclusion must be considered the dependence of development upon function. For instance, a study of the organs of mastication of the anthropoid ape (man's prototype) reveals massive structure, de-

Fig. 7.—Observe the asymmetric development of the bones of the skull of a dog due to the interference with the function of the upper left lateral half of the dental apparatus.

manded by the functional activity incident to the mastication of the kind of food available for his sustenance and upon which his existence depended.

With the development of modern methods for refining the raw materials to be used as food and the acquirement of the epicurean habit—which demands the preparation of complex, highly seasoned food calculated to stimulate pleasurable sen-

Fig. 8.—Upper aspect of the skull shown in Fig. 7.

sations in those whose appetites are already satiated by over-indulgence—the necessity for vigorous muscular effort has been removed and the stimulating effect of vigorous functioning has been lost. The lower part of the face has thus been

reduced in size but the teeth have not relatively changed. The result is that the teeth of many people are out of harmony in size with the rest of the features.

All variations from the normal in the development of the various units, which are interdependent, must of necessity affect the proper functioning of the organism as a whole and, therefore, become problems in hygiene.

Although there is a difference of opinion on this subject, there are orthodontists who believe that the normal development of the oral structures is also impeded by substituting

Fig. 9.—Deformity from lack of function. Ankylosis prevented the movement of the jaw.

the artificial feeding of the infant in the place of breast feeding. Whoever has observed carefully the infant in the act of nursing must have noticed that much exertion is put forth in the effort to obtain the milk. It is upon this muscular effort, and the enforced position of the oral structures during the act of sucking and swallowing that normal development is in a considerable degree dependent. No bottle feeding device perfectly simulates the breast or affords the vital muscular resistance which supplies the essential stimu-

lus for the development of the oral structures of the growing infant.

Deforming Habits.—Deformities of the face and jaws arising from mouth breathing or other habits contracted in infancy, such as thumb-sucking and the continued use of pacifying devices, deserve consideration.

One of the most common causes of mouth breathing is the presence of *adenoids* in the posterior nares which so fill up the space required for normal breathing that the child resorts to mouth breathing in order to obtain sufficient air. Adenoids

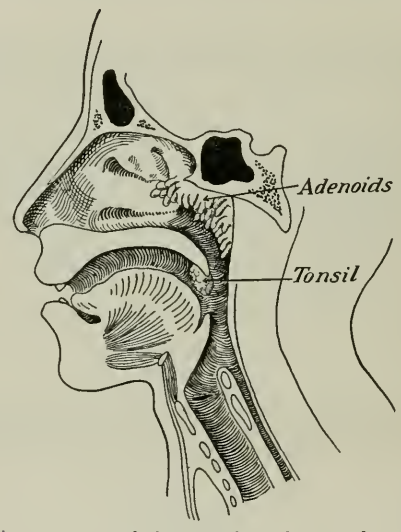


Fig. 10.—The air passages of the mouth and nose showing their relationship to the adenoids and tonsils.

are enlarged lymphoid follicles. These follicles are normally present in the nasopharynx but from various sources of irritation they frequently become congested and swollen.

The deformities resulting from the use of *pacifying devices* are frequently seen; and their use reflects either a lack of intelligence or disregard for the welfare of the child. In any case the resulting deformity is a constant rebuke to the parent.

Thumb-sucking may be overcome by enclosing the child's elbow in a long stiff cuff of gay material, not as punishment but as a game. The deformity of drawn-in dental arches which results from thumb-sucking is so characteristic as to be unmistakable. It not only interferes with the functioning of the teeth but destroys the entire contour of the mouth.

2. Structure of the Teeth.—Nature has protected the teeth by furnishing for their outer covering the hardest substance to be found in the body. A difference in opinion exists in regard to the question of variation in the hardness of the

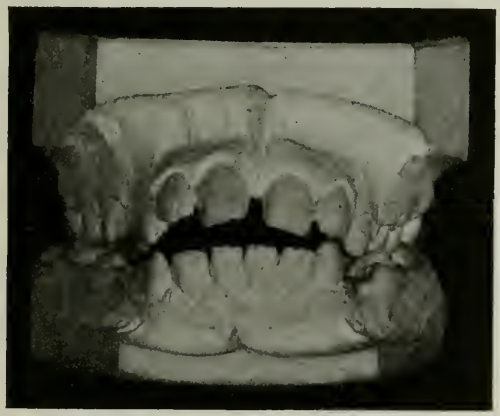


Fig. 11.—Deformity due to thumb-sucking.

teeth in different individuals and at different age periods of the same individual.

Pickerell found that enamel is not impermeable and that stain penetrates to a varying depth in different teeth; moreover, the permeability varies in ratio to the length of time a tooth has been erupted. This would seem to prove that enamel does change its character after the eruption of the teeth. He also found that the density or compaction of enamel was in direct ratio to the time elapsed since its formation. The hardness of enamel was tested by determining

the comparative resistance to scratching. The result of his experiment seems to be conclusive that there does exist a decided difference in the hardness of teeth. The hard teeth he terms *sclerotic,* and the soft teeth *malacotic.* He believes that

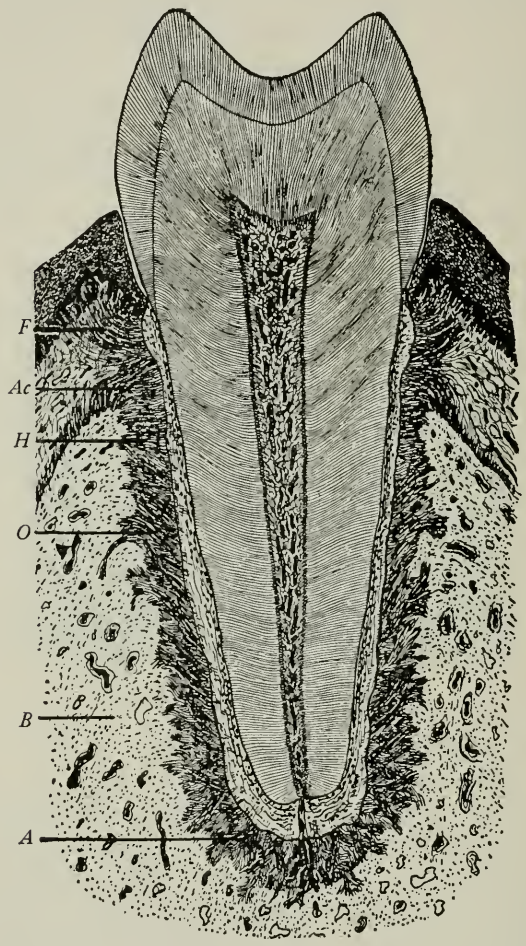


Fig. 12.—Diagram illustrating groups of fibers of the gingivæ and peridental membrane. Bucco-lingual section through a bicuspid tooth and investing tissue. *F,* Free gingivæ group of fibers; *Ac,* Alveolar crest group of fibers; *H,* Horizontal group of fibers; *O,* Oblique group of fibers; *A,* Apical group of fibers; *B,* Bone or alveolar process. (Black's "Special Dental Pathology.")

the permeability, density and hardness are important factors in the predisposition to caries since malacotic teeth would more readily permit the penetration of the oral fluids.

Howe in his experiments upon animals has actually produced caries by depriving them of their natural food, such as green vegetables, milk and other substances rich in mineral content and vitamins.

From a clinical standpoint most surely a consensus of opinion would be that the character of the hard tissues of the teeth does vary at different periods in life, and the physical characteristics of the teeth are affected by the general physical condition of the individual. There is also ample evidence that the presence of sufficient calcium in usable form in the diet of the expectant mother and the diet of the infant,—that is, during the period while the teeth are being laid down,—is of fundamental importance in determining the quality of tooth structure.

3. The Saliva.—The role played by the saliva is also a very important one among the defensive or protective agencies, and its presence and constant renewal tends to maintain the normal environment of the teeth and to overcome by its neutralizing effect the harmful action of fermentation. In general terms it may be stated that the saliva is composed of water, albumen, mucus, ptyalin and the salts of potassium and sodium held in solution. The proportions vary in different individuals and in the same individual at different periods of the day. The amount of its different components will be affected by the physical condition of the individual and by the kind of stimulation inciting its flow.

Saliva varies also in its physical characteristics from a thick, viscid, mucilaginous substance rich in albumen and mucus to a thin watery fluid containing small quantities of colloid material. Carbon dioxide is always present in the saliva as in the blood and other body fluids.

The action of the *ptyalin* content is to convert starch into sugar during the process of mastication. Thorough mastication is essential to obtain the full effect. The sense of taste will quickly detect the change taking place, the sweet taste increasing as the chemical action proceeds. According to Black the ptyalin has a still further function in freeing the surfaces of the teeth and the embrasures of the clinging particles of starchy foods which remain after the mass has been swallowed.

The function of *mucus* in the saliva is largely a mechanical one. It lubricates and makes slippery all the surfaces of the tissues. It coats the teeth and imparts to their surfaces a smoothness and softness not otherwise obtainable. During mastication it mixes with the food and prevents it from sticking to the surfaces of the teeth, gums and mucous membrane of the mouth. It aids in forming the bolus of food which makes easy the act of swallowing. A deficiency in the amount of mucus will be evidenced by difficulty in the management of food in the process of mastication.

The *water* of the saliva acts by its presence, bathing the surfaces of the teeth, this action being promoted by the movement of the muscles of the cheeks and tongue, by which it may be forced through the interproximal spaces or drawn through by the action of suction. The habitual use of this function as a regular exercise in performing the toilet of the teeth may be of marked benefit.

Thorough mastication also influences the composition of the saliva. With an increased flow brought about by the stimulating influence of the exercise of mastication the alkalinity is raised. It has been shown by Pawlow that glandular secretions have the property of adaptation; in other words the degree of alkalinity is largely influenced by the character of the food to be acted upon. In periods of physiologic rest the saliva is weakly alkaline and the quantity secreted is only about 1 c.c. per minute, this amount being greatly increased during the period of active functioning,

the increase depending largely upon the nature of the food material. It is interesting to note that in cases of dry mouth the teeth quickly crumble away. A marked increase in caries is usually noted in any pathological disturbance of glandular activity. Prinz states that "the quality of the secreted saliva is the sole factor which governs environmental phenomena concerning tooth decay."

ORAL PROPHYLAXIS

Caries.—The subject of dental caries has engaged the attention of scientific minds for more than four hundred years and, although much has been accomplished toward the solution of the problem, it still affords an ample field for research.

Fig. 13.—Deformity resulting from neglect of the teeth.

In 1530 a German writer published a statement so closely in accord with modern findings as to be prophetic of the later work of Miller and others. The following is a translation taken from Black's *Operative Dentistry.*

Caries is a disease and evil of the teeth in which they become full of holes and hollows, which most often affects the back teeth; especially so when they are not cleaned of clinging particles of food which decompose, producing an acid moisture which eats them away and destroys them so that finally with much pain they rot away little by little.

Prior to the work of John Tomes, who gave to the world in 1860 the results of his microscopical studies of dental tissues, but little was known of the histological structure of the teeth, and caries was generally regarded as an inflammatory process, having its origin within the dentin of the tooth affected. Tomes found that the structure of dentin was such that a true inflammation was impossible, there being no circulatory system.

In 1857 Lieber and Rotenstein, using an iodin stain, showed the presence of bacteria in decayed teeth.

Fig. 14.—The case seen in Fig. 13 showing the malocclusion due to caries.

Later work (1882) by Miller and others brought out the following facts:

(1) In the decay of enamel the original foci of decay are found in locations permitting the undisturbed confinement of food material and the formation of sufficient acid by the process of fermentation to dissolve the enamel.

(2) The dentin, which is the main substance of the tooth below the outer, harder enamel layer, always contains bacteria in the tubules when decay is taking place.

(3) The fermentation of carbohydrate foods by mouth bacteria produces lactic acid.

(4) Lactic acid causes decalcification of the dentin, this process being followed by the decomposition of the organic matrix.

Why this carious process is active in some mouths and passive in others equally neglected remains undecided. It may be that in the normal secretions of some mouths there are substances capable of holding in abeyance the development of bacterial flora. It may be that through the refinement of food material and the development of epicurean tendencies, which eliminate the necessity for vigorous exercise in mastication, the stimulating effect upon the secreting glands with the neutralizing action of a copious flow of saliva is lost. Or perhaps the solution of the problem lies in the resistance of the enamel itself due to its composition and density. Slight imperfections in the structure of the enamel are almost invariably present, thus making the dentin easy of access to the fermentative bacteria of the mouth.

Howe in his research work on caries at the Forsyth Dental Infirmary found that a few species of highly aciduric microorganisms were responsible for the carious process. He obtained these findings by first sealing carious cavities with cement, thus separating the carious material from the flora of the mouth. The bacterial cultures were later secured from the layer of carious dentin which had been thus isolated.

Although the problem of caries has been seemingly solved by the work of Miller and others, yet there are undoubtedly factors related to the question of immunity which are not yet understood; and it may be that nutrition plays a larger part than we now comprehend.

Diet in Relation to Decay.—Inasmuch as the protective covering of the teeth is fully completed at the time of eruption, too much stress cannot be laid upon the building up of these tissues or upon the diet of children up to the twelfth or thirteenth year.

The most universal food and the one containing in itself all of the three nutritive constituents, viz., proteids, carbohydrates and fats, is milk. Milk is also the richest of all articles of diet in the calcium content, this being the element of greatest importance in the development of the bones and teeth. A liter of milk contains 1½ grams of lime, which is a larger quantity than is contained in a similar amount of lime water.

The mineral content of milk is sufficiently high to give it the first place as a bone building food, and as the teeth re-

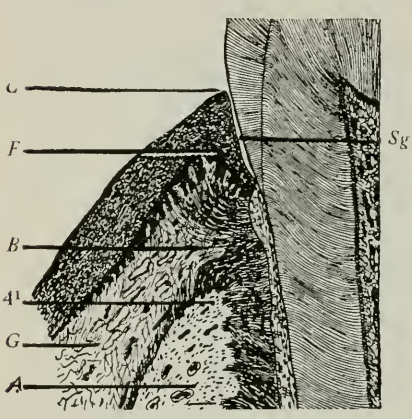


Fig. 15.

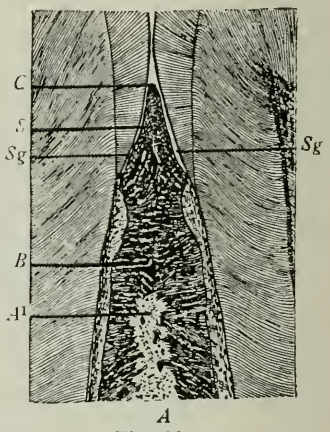


Fig. 16.

Diagrams illustrating nomenclature of gingivæ. (Black.)

Fig. 15.—Buccolingual section through tooth and investing tissues. *A*, Alveolar process; *A*¹, Crest of alveolar process; *G*, Gum; *B*, Body of gingiva; *F*, Free gingiva; *C*, Crest of gingiva; *Sg*, Subgingival space.

Fig. 16.—Mesiodistal section through first and second bicuspids and septal tissue. *A*, Alveolar process; *A*¹, Crest of alveolar process; *B*, Body of gingiva; *S*, Septal gingiva; *C*, Crest of septal gingiva just below contact point; *Sg-Sg*, subgingival spaces.

quire practically the same elements for their proper development it is of equal importance as related to them. The infant requires about one-third gram of lime daily and this amount is supplied in milk. A deficiency in lime may lead to softening of the bones and imperfect development of the teeth. Next to milk come eggs, then the cereals and then certain

vegetables such as carrots, asparagus and spinach. Milk and vegetables also contain vitamin substances which seem necessary in making the calcium available for the building of bones and teeth.

The mineral content of foods during gestation should be carefully considered in the dietary of the prospective mother, as the proper nutrition of the developing fetus is essential in the formation of enamel. On the other hand the development of the dentin, cementum and alveolar process takes place in a large measure after birth and continues throughout the life of the individual. Hence proper nutrition in infancy and later life is essential for the upbuilding of these tissues.

Great stress is laid upon the habitual use at each meal of foods selected not only on account of the nutrient qualities, but also because they require sufficient masticatory effort to make vigorous exercise necessary in the performance of this function. Vigorous mastication gives the necessary stimulation to the peridental membrane, which being richly supplied with blood needs this stimulation and functional activity for the maintenance of tone. There is an increase in the flow of saliva and exercise is afforded for the muscles of mastication. The passing of the food materials over the teeth cleanses their various surfaces and massages the gums and gingivæ.

Prophylactic Treatment.—The dentist recognizes the importance of the health of the soft tissues and will advise his patients regarding the care of the gums as well as the care of the teeth. The great benefits to be derived from prophylactic treatment of the teeth and gingivæ were first brought to the attention of the dental profession and public by Dr. D. D. Smith of Philadelphia, who was able to demonstrate that dental caries in a large percentage of individuals is preventable. His treatment consisted in frequent polishing of the surfaces of the teeth with suitably shaped orangewood points impregnated with flour of pumice.

Fig. 17.—Dental hygienists at work in the Prophylactic Clinic for Boston school children at the Forsyth Dental Infirmary for Children. It is here that the Forsyth and Tufts School for Dental Hygienists is conducted.

It is quite obvious that in order to carry out the regime of Dr. Smith the dentist with a clientele of moderate size would be obliged to devote his entire time to the cleansing and polishing of teeth and that he would be unable to attend to the operations demanding his highest skill. It followed therefore that dentists undertaking to carry out this polishing, as a regular routine in practice, were obliged to seek aid; and the problem was finally solved by training young women to act as assistants. These Dental Hygienists are employed, not only by private dentists, but also by school departments and health depeartments for work with school children.

Daily Care of the Teeth.—We believe that the care of the teeth should begin as soon as the child is put upon a mixed diet and even before this if there are evidences of accretions upon the surfaces of the teeth. The brush should be of suitable size to suit each individual case, not too large to pass between the lip and cheek and the surfaces of the teeth, and with bristles neither so stiff and resistant as to cut the soft tissue nor so soft as to be ineffective in the removal of soft material. Prior to use the new brush should be rinsed in boiling water. No definite method or rule can be made for brushing the teeth of young children. The parent or nurse must take care that it is done thoroughly without injuring the soft tissues.

Method of Brushing the Teeth.—The child should be early taught to use the toothbrush properly. Whatever method is advocated the object is the same, namely the removal of all extraneous material and the stimulation of the soft tissues without injuring them.

Fones advocates the following method of brushing:

Place the toothbrush inside left cheek and on upper gums, and nearly close the teeth together. Make the brush go backward and downward to lower gums, then slightly forward and upward until it has traveled a complete circle. This circular motion should be done rapidly so that the gums will be stimulated and the teeth cleansed of food.

Keep up this fast circular motion and brush all the teeth on the left side as well as all of the front teeth. Do not brush the teeth and gums crosswise.

Now brush the right side with the same circular motion or reversing the circle if found more convenient. Brush long enough to thoroughly stimulate the gums and cleanse the teeth, going back and forth over all the surfaces several times.

With the bristles of the brush pointing upward and the end of the thumb on the back of the handle, brush the roof of the mouth and the inside gums and surfaces of the teeth with a fast in-and-out stroke, reaching back on the gums as far as you can go. Go back and forth across the roof of the mouth with this in-and-out stroke at least four times.

Hold the handle of the toothbrush in your fist with the thumb lying across the back of the handle and brush the gums and teeth with an in-and-out stroke, using chiefly the tuft end or toe of the brush. Reach back in the mouth on the gums below the last tooth on both sides and brush with a fast, light, in-and-out stroke. Tip the handle of the brush up in brushing the gums back of the lower front teeth.

Lastly, brush the teeth with an in-and-out stroke on the surfaces on which you chew, as the food must be removed from the grooves or fissures of the molars.

The teeth should be brushed with sufficient frequency to prevent the fermentation of food with the formation of acid. Four times a day has been advocated, once after each meal and before retiring at night. The time of greatest importance is before retiring; for in sleep the muscular tissues of the mouth are at rest and the oral secretions greatly lessened, thus affording the most favorable opportunity for undisturbed action of the acid-forming bacteria. This final brushing should never be neglected. The danger of infection of the soft tissues of the mouth by proper brushing is so slight as to be practically negligible.

Care of the Brush.—As the result of experiments to determine the most hygienic method of caring for the brush the author has found that a brush rinsed in water after using and then placed in a closed receptacle developed many more bacteria than one which was rinsed in hot water and left in the air to dry. It is therefore advised that the brush be

thoroughly rinsed in *hot* water after each use. The brush should be freed from water as much as possible by shaking and then hung in the air in a place protected from the dust.

Dental Floss.—The use of dental floss is to remove any particles that may remain upon the proximal surfaces of the teeth after brushing or after eating when it is not possible to brush the teeth. The silk should be passed through the contact points and held closely to the surface of the teeth and carried upward or downward as far as the gingivæ.

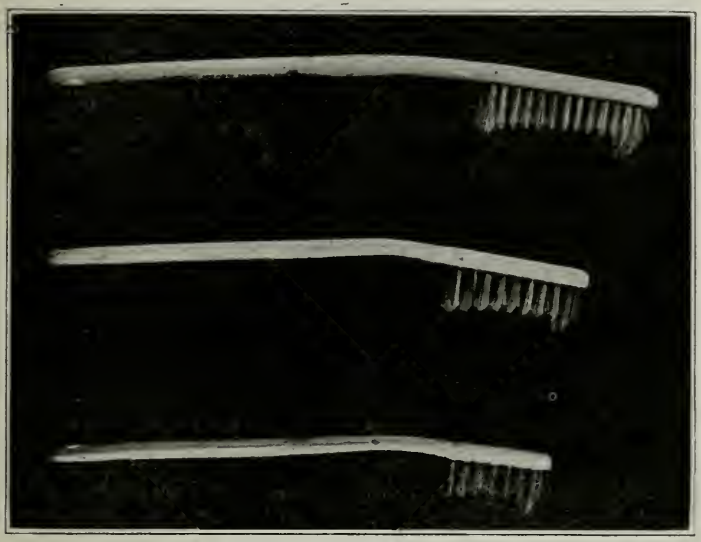


Fig. 18.—Tooth brushes of proper shape and material are made in different sizes for children and adults. The cut shows such tooth brushes exactly one-half normal size.

Care must be taken or injury will be done. If the contact point is close, the force used may result in the sudden passage of the floss and carry it against the soft tissues so roughly as to cause damage.

Toothpicks.—The toothpick is also used to clean the proximal surfaces of the teeth after eating. An orangewood pick with a smooth flat blade or a quill is to be preferred

and care should be taken not to injure the soft tissues or push the gingivæ away from the surfaces of the teeth. Too often people blindly and violently thrust the toothpick between the teeth, in an attempt to relieve some slight irritation, until actual bleeding of the gums is produced. Another vicious and unsightly habit is the prolonged use and chewing of the cheap wooden toothpick from which splinters are detached to irritate the membranes of the mouth and throat. The toothpick should be used privately, not publicly.

Mouth Washes, Tooth Powders and Pastes.—Prinz states that the *sterilization* of the oral cavity by any antiseptic which can be employed with safety is impossible. This being the case, the use of commercial preparations advertised to do this is not only useless but may be harmful, and their use should be condemned.

We have shown that the saliva possesses many of the desirable qualities of a mouth wash. The ideal *mouth wash* should be of a similar nature, with the addition of a bactericidal property. The qualities of the mouth wash should be such that it will not irritate the soft tissues, that it will not destroy the salivary ferments, that it will be bactericidal, that it is not poisonous if swallowed. The wash should be readily available and inexpensive so that it may be used freely and without harm. Salt and water may be used for this purpose. Prinz has shown that physiologic salt solution reduced the oral flora by 50 per cent, and he advises the use of this solution with the addition of half an ounce of lime water to eight ounces of a salt solution. The lime water is mildly astringent and is a solvent of mucinous material. Fones advocates the use of lime water alone, and states that five cents worth of coarse unslaked lime such as the masons use for coarse plaster will keep a family supplied with the best kind of mouth wash for a whole year.

Tooth powders are largely used as an aid in mechanically cleansing the surfaces of the teeth. Much injury may result from the use of an abrasive material and only the finest pre-

cipitated calcium carbonate should be used for this purpose. This may be combined with a small amount of soap and saccharine and flavored with one of the essential oils. A suitable powder may be made by thoroughly mixing a half-pound of finest grade English precipitated chalk with three grains of finely powdered saccharine, a half-ounce of powdered castile soap and 50 to 100 drops of oil of wintergreen or peppermint.

Pastes are made by adding gelatine or glycerine to the powder.

Tooth Cleansing Foods.—The use of slightly acid fruit as the last article of food to be eaten in a meal is to be commended for its efficacy in the removal of sticky particles of food and its stimulating effect upon the salivary glands, thereby promoting a free flow of saliva which quickly neutralizes the acid. The lunch which the child carries to school should contain an apple or an orange for dessert instead of the jam, cookies and sweets so often used.

Care of the Mouths of Children.—It is of the uttermost importance that the growing child should be taken to the dentist for frequent examination. Beginning at the age of three years a careful inspection should be made at least every three months. This inspection should include not only an examination for cavities of decay, which should be immediately treated or filled, but also a study of the dental arches to determine whether normal development is taking place. Slight stimulation by properly directed but gentle force may be necessary to bring this about. If retarded development is discovered early, very little interference is necessary to stimulate growth but if neglected the consequences may be serious. The treatment of incipient caries by the dentist by the use of nitrate of silver will frequently inhibit decay, and the necessity for filling the deciduous teeth may be avoided.

One of the most common defects developing in the mouths of children has been the decay and loss of the six year molars, which come in just back of the baby teeth. These teeth

are the first of the second set to appear. They decay readily and have often been lost before parents realized that they were permanent teeth. Their loss causes a disarrangement and drifting of the other teeth of the second set.

Septic Teeth as a Source of Systemic Disease.—Much has been written on this subject and investigators of prominence both in medicine and dentistry have, after exhaustive research, arrived at conclusions so similar as to justify the statement that in a variable percentage of persons suffering from lesions of the kidneys, heart, joints, and disturbances of the glandular system, x-ray and bacterial examinations will reveal the presence of septic foci around the roots of one or more teeth. The removal of these teeth is often followed by marked improvement of the general symptoms.

Rosenow, in the *Journal of Dental Research,* Vol. 8, No. 3, states that the number of persons suffering from diseases directly attributable to dental foci of infection as well as from nonrelated conditions which have been cured or benefited by elimination of foci of infection, in various branches of medicine, is so large as to be quite sufficient to prove the general truth of the idea of causal relationship. He advises the removal of all nonvital teeth in persons suffering from arthritis, heart or kidney affections, and some other forms of disease for which other causes cannot be found. It is easy to see the possibility of an infection spreading from the region of the mouth to other parts of the body; but we believe that the number of cases attributed to this cause has been greatly overestimated. Cases are on record showing an undoubted relationship between systemic infection and dental foci by the marked improvement produced by the elimination of the diseased teeth. No dentist or physician, however, would act upon the hypothesis that diseased teeth represent the sole cause of these systemic diseases and advise wholesale extraction. The extent to which infections about the teeth

may be the cause of disease in other parts of the body is to be determined in any particular case by the physician and the dentist. But the relationship between oral and general health is sufficiently well established to give added importance to the care of the teeth through both prophylaxis and diet.

CHAPTER IV

THE HYGIENE OF ACTION

Two Kinds of Bodily Activity.—Independent activity of the organism begins with birth and ends only with death. Even the person who avoids physical exercise carries on a variety of muscular activities including the beating of the heart, breathing, and the functions of walking, riding, sitting, standing, eating, gesturing, talking, etc. Some of these activities are involuntary and others are so simple as not to require careful attention, but in all these activities and in a contrasted group of activities which we may term active physical exercise, there arise certain problems of hygiene.

EXERCISE

Voluntary muscular activity or exercise will be first considered. The professional man or the individual engaged in a sedentary occupation will do well to give careful attention to the beneficial effects of regular and proper exercise and to the dangers incident to its neglect. Exercise is more essential to his happiness than mental development is to the happiness of a man employed in active physical labor.

It is a pernicious fallacy to regard healthful and vigorous exercise as an unnecessary burden in the day's work merely because the changed living conditions since the days of our forefathers have rendered mental activity the usual, and physical activity the unusual mode of life for the professional, business and clerical classes. Especially among the intellectually inclined there is danger that the desire for a good physical condition of the body may stop with the envy of those who possess such a body or with an attempt to secure the same stimulation in another way or by an easier road, in using massage, alcoholic stimulants, drugs and patent medicines, instead

of learning the real delight and joy of a proper physical condition resulting from well-directed exercise.

What Exercise Does for the Body.—Briefly, what are the real and actual effects of regular physical exercise upon the body? In the first place it is a most important stimulus to the *circulation* of the blood and the lymph. The movement of the muscles and other organs exerts a massaging action on these two streams in the capillaries and lymph spaces; and the increased respiration exerts a suction upon the venous blood into the great veins near the heart by the same bellows-like action with which air is drawn into the lungs. This increased breathing is also important to the *lungs* themselves in filling air spaces which under normal conditions may not be used, and particularly in inflating the apical regions of the lungs.

The increased bodily activity increases the *oxidation* going on in the body. The extent of this action is shown by the fact that the output of carbon dioxide is increased from three to ten times by muscular activity whereas the digestive process only increases its output one-fifth. This carbon dioxide is thrown off through the lungs. Water is another waste product and the *skin* is cleared by the generous excretion of the sweat glands and the consequent softening of the horny layers.

The most generally obvious aspect of exercise is the building up of the general *muscular system* which constitutes two-thirds of the bulk and weight of the body. Muscle fibrils increase in size when used but when unused they decrease until hardly more than the connective tissue remains of what should be a strong and vigorous muscle. Nor is this unimportant for the man of sedentary occupation, because for everyone there are emergencies which must be met by unusual physical energy. Running for a street car, running upstairs, or sudden emergencies which occur in the professional activity of the dentist or physician, require physical energy and often considerable muscular strength. This need of reserve strength is especially important in the case of the *heart* which like

the skeletal muscles is built up and strengthened by proper physical exercise. In the emergencies cited above and in certain diseases like pneumonia it is primarily important that the heart is sufficiently strong to withstand the strain. In fact, in disease the strength of the heart often determines the question of life or death.

But the other internal organs also gain vastly from physical exercise. The viscera are relieved from serious *internal congestion* which is likely to take place in the body of a sedentary individual and which predisposes the internal organs to diseased condition. The stagnation of the blood and lymph in the large vessels running from the digestive organs to the heart interferes with digestion, circulation, and the sense of physical well being. *Digestion* itself is aided by the increased peristalsis produced by the churning activities of these organs and by the increased use of the abdominal muscles.

To anyone who has learned to enjoy physical exercise it is not necessary to say that the general toning up of the bodily activities, the improvement of the circulation and all the attendant changes mentioned above, produce a beneficial effect on the *mental tone*. Of equal importance is the effect upon the *heat-regulating mechanism*. Muscular activity opens the small blood vessels of the muscles and the region near the skin and contracts the blood vessels of the internal viscera. It is upon our ability to make these changes that we rely in large part for our bodily adjustments to changes of temperature. A trained and adaptive heat-regulating mechanism is therefore essentially important to the general health.

In summarizing the foregoing we may list the beneficial effects of muscular exercises as (1) an aid to circulation, (2) an aid to oxidation, (3) an aid in the elimination of waste, (4) clearing the skin, (5) strengthening the muscular system, (6) aiding digestion, (7) improving the mental tone, (8) relieving internal congestion, (9) strengthening and en-

larging the lungs, (10) strengthening the heart, and (11) improving the heat regulating mechanism.

Types of Physical Exercise.—The type of physical exercise which one may take depends upon his physical fitness, age and inclination. It is far better to build a good body in youth and to maintain its efficiency throughout life, but it is never too late too begin bodily improvement provided this is done in a sane and proper manner. To allow a horse to remain in the stable for weeks then drive it a hundred miles in a day would spoil the animal; yet many people expect the human mechanism to accomplish similar feats, in rare and immoderate exercise. Some who rarely exercise go to excess because when the opportunity to exercise offers itself there is a joyous outlet of pent-up energy and the individual does not realize (at least until he tries to get out of bed the next morning) that an unused muscular system has its limitations. Others overdo because they have once been athletic and do not realize that absence from regular exercise has depleted their powers of endurance.

The first requisites of the most helpful exercise are that it should be regular, enjoyable, and adapted to the individual. The person who religiously resolves to attend the gymnasium at least three times a week finds that after the second or third week it begins to pall on him. If he is taking routine exercises, he goes through a definite set of mental processes. As the hour approaches for him to enter the gymnasium he has a feeling of dislike for the task and is sure that he would prefer continuing his office activities. Through moral force however he persuades himself to go, and after completing his exercise and being refreshed by a shower bath he feels so invigorated that he firmly resolves to enter the gymnasium six times a week instead of three. Yet the same compulsion must be exercised the very next day if he is to resume his exercises.

The strengthening of the physical and mental fiber will certainly repay this individual if he persists in the regular

routine of exercise. Gymnasia are invaluable assets in the life of the city. If, however, the exercise can be varied so that the man takes a delight and looks forward to the time when he will have an opportunity to exercise, much is accomplished. With some individuals the innovation of athletic games accomplishes this result. Such a man takes a keen joy in a contest; in making himself expert and proficient in a particular way. Still another type of mind dislikes any activity which is not productive. Hunting, fishing, exploring, training horses, gardening, carpentering, etc., all appeal to such a man and fortunate is he who can elect his ideal exercise from this group. These activities, however, are not always available to the occupant of a five room flat; so perhaps we should say most fortunate is the man who can become fond of any of the types of physical exercises mentioned.

Rhythm in Exercise.—More should be said about the nature of the exercise itself. It should involve rhythmic and not continued muscular contraction. A type of exercise like tennis, baseball, or football is a much more general and invigorating bodily exercise than the mere lifting of heavy weights. The exercise should be such that free play is granted to the various parts of the body. The lungs should be free to expand to their fullest extent, and the movements of the trunk should be free and easy. That exercise is most helpful which is sufficiently varied to call into use a great number of the muscles of the body. Above all things the exercise should be reasonably vigorous.

Walking.—Walking, which is an excellent exercise and available to everyone, should never be confused with loitering or strolling. Fast walking in the open, especially in the country, is invigorating, restful and has the added advantage of making the man interested in his surroundings and in the wonders of the natural world which he was meant to enjoy. Mere strolling even though it be in the open is not proper

exercise and is tiring rather than restful. Air is good and essential but the mere breathing of fresh air cannot take the place of physical exercise.

ORDINARY BODY ACTIVITIES

The other phase of the Hygiene of Action, which we men tioned in the beginning of this discussion, concerns the proper use of the body in the ordinary affairs and conduct of life. This involves also the matter of figure, bodily shape, and physical force; because these depend upon the proper coordination and balance of the muscular system.

Figure.—Good figure and proper carriage are important not only in the personal appearance of the individual, directly affecting his personality and the estimate set upon his ability by the casual observer; but they are also important to health as deformities injure and restrict adjacent organs. The body is largely made up of opposing sets of muscles which tend to move the various parts in the opposite directions like the flexor and extensor muscles of the lower leg or arm. Similar sets of muscles alter the position of the neck, the chest, the back and the jaw. We shall see how the improper use of particular muscles may distort the normal figure of the body. This is particularly noticeable respecting the shoulders, the neck, the back, the abdomen and the feet. The proper mechanical use of the body is quite as important as exercise, and indeed exercise may be even harmful if the body lacks proper muscular coordination.

Round Shoulders.—Round shoulders have become so common among large groups of sedentary workers that there is danger that we may conclude that they are normal. The round-shouldered individual himself is likely to feel that he has assumed an abnormal position when he straightens up. When straight he looks unnatural merely because he is not in his habitual or customary position. When we look at the bearing of the well-trained soldier, we realize how odious is round-shoulderedness compared with the natural contour.

This condition is brought about by drawing the shoulders forward through the contraction of the muscles of the chest and the disuse of the muscles of the back so that finally the muscles become set in this position with the chest muscles contracted and the back muscles relaxed leaving the shoulders in a forward position, cramping the upper part of the chest and limiting the breathing. This deformity is brought about by a careless attitude at the desk or by leaning forward over one's work, and the individual must develop consciousness of

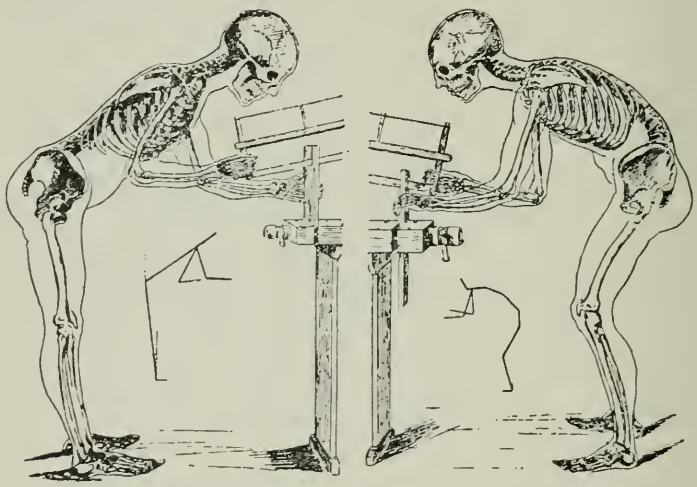


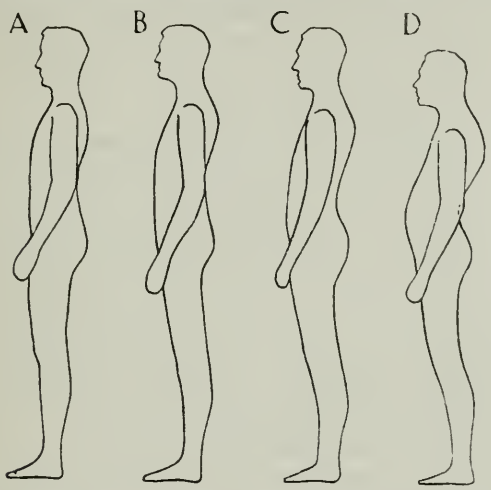
Fig. 19.—Good (left) and bad (right) postures. The main lines of the body are shown in diagram and it is easy to see that the position at the right would be much more tiring. (Burgerstein.)

physical position in order to avoid incorrect posture. Corrective exercises, in consciously throwing the shoulders back with the arms widely extended to one side, or in raising the arms above the head, at the same time drawing a deep breath and dropping the arms slowly during the period of exhaling, keeping the hands well to the rear, are effective in correcting this condition.

Carrying the Head Forward.—Another malady which often accompanies round shoulders is the fault of carrying the head too far forward. The neck becomes accustomed to

an abnormal position and is no longer erect. This again is due to the weakness of the muscles which hold the head back, and the set contraction of the muscles which pull the head forward. One of the first corrective exercises for both these conditions is that of flattening the back against a straight, perpendicular wall. The individual backs up to a door or wall and places himself in such a position that the calves of the legs, the hips, the shoulders, and the back of

TRACINGS MADE DURING EXAMINATION OF 700 HARVARD FRESHMEN



Group A—7.5% Group B—12.5% Group C—55% Group D—25%

Fig. 20.—Posture chart showing the result of the examination of Harvard Freshmen.

Group A.—Good mechanical use of the human body. 1. Head straight above chest, hips and feet. 2. Chest up and forward. 3. Abdomen in or flat. 4. Back usual curves not exaggerated.

Group B.—Fairly good mechanical use of the human body. (Note changes from Group A.) 1. Head too far forward. 2. Chest not so well up or forward. 3. Abdomen very little changed. 4. Back very little changed.

Group C.—Bad mechanical use of the body. (Note changes from Group A.) 1. Head forward of chest. 2. Chest flat. 3. Abdomen relaxed and forward. 4. Back curves are exaggerated.

Group D.—Very bad mechanical use of the body. (Note changes from Group A.) 1. Head still farther forward. 2. Chest still flatter and farther back. 3. Abdomen completely relaxed. "Slouchy." 4. Back all curves exaggerated to the extreme. (Lee.)

the head lie flatly against the wall. This is approximately the normal posture and if a man walks away in this position and maintains it for some time, repeating the exercise every morning he will gradually accustom himself to the proper position of the head and shoulders and this position will become the natural one. Another way to exercise the muscles at the back of the neck is to clasp the hands behind the head and force the head back against their pressure.

Spinal Curvatures.—Another common fault in posture is the abnormal curving of the spine either laterally or backward at the region of the thorax or forward at the region of the abdomen. This latter is often associated with protrusion of the abdomen by increase in fat and the relaxing of the ventral abdominal muscles.

The straightness and strength of the back may be improved by persistently trying to make oneself as tall as possible, holding the back straight and rising on the toes with arms extended over the head, stretching the arms and body. The objectional "pot belly" condition may be successfully prevented and largely overcome by such exercises as lying flat on the floor or bed with arms folded and raising the feet and head alternately. Lateral curvatures sometimes arise from sitting in a leaning position and are most common in children who sit improperly at school.

Deformities of the Feet.—Less conspicuous but none the less important deformities are those which are found in the feet. In selecting shoes man seems to conclude that nature made a mistake in making the foot broad at the toe and he endeavors to make it over into a wedge-shaped organ; while woman tries to improve upon nature by walking upon the toes and elevating the heels instead of walking upon the flat of the foot. If you will observe an infant or small child you will find that the toes are flexible and move sideways and backwards and forwards to a great degree. When a child walks the toes "dig into the ground." Held in by the shoes in later life this early flexibility and the original

shape of the foot are largely lost. Especially in people who, like dentists, are required to remain on their feet for many hours a day, do we find painful and harmful foot conditions.

There is a natural arch running from the heel to the ball of the foot and a small transverse arch (from side to side) at the base of the toes. These arches are held in position by a complex group of muscles. If these muscles are not used or if they are so bound up that they are not given proper free play, the weight of the body, centering in front of the heel, tends to break down the arches and produce a condition known as flat foot. This defect will be rather prevalent until common sense rules fashion and people demand proper shoes.

To take proper care of the feet the shoe must be as wide as the foot, the heels must be low and broad, the toes and uppers of the shoes must be flexible, there must be room for activity at the toes of the boot and the foot must be held in such a position when walking that it is carried straight ahead. In a normal foot the line drawn through the long axis of the great toe should also pass through the heel.

The foot must be given proper exercise to strengthen the muscles of the ball of the foot and the arch. Dig the toes into the ground when you walk, practice the ordinary gymnastic exercise of "heels raised, knees bend," thus calling the muscles of the foot into play. Do not wear the shoe or the garter so tight as to cause congestion of the blood in the foot. All of these things are very important in securing fair treatment for one of the most abused members of the body.

The public must learn that from the aesthetic standpoint a small foot with a pointed toe and high heel is not the ideal foot.

Such is not the foot of the Apollo Belvedere nor that of the Venus of Milo. It is simply a deformity, belonging in the same category with the constricted waist, and far more harmful to its possessor than the ear or nose ornaments of the Hottentot. No hygienic lesson is more im-

portant than that clothing should fit the body and not the body the clothing.—*Sedgwick.*

Sight and Hearing.—Proper use of the eyes and ears forms an important part in the ordinary activities of life although somewhat removed from the subject of muscular action. Both of these complicated sense organs require expert attention if there is anything seriously wrong. Their importance and their complexity both demand this. We should remember that headaches and even the nausea accompanying the so-called "sick headache" may be produced by defects in the eyes which are perhaps more often congenitally abnormal than any other organ.

The care of the eyes should begin at birth. The physician cleanses the eyes of the newborn to protect them from a possible infection, which, if contracted from the mother and neglected, may cause total blindness. Infection of the eyes of the newborn (most commonly of gonorrheal origin) is, in fact, the cause of much blindness in our institutions today.

Later troublesome infections are styes, pink eye, and granulated lids which, in malnourished children, may become susceptible to trachoma. Early habits of cleanliness must be established, individual towels enjoined, and in any case the child's eyes should be examined by a skilled physician before he begins school.

We can do much to take care of the eyes by being careful to use a steady and not a flickering light when we read, by choosing paper which is dull and not of a glossy finish, and by avoiding in so far as possible, the use of any print so fine that it is necessary to hold the book less than eighteen inches from the eyes. Occasionally the eyes may be rested from the work immediately at hand by changing the focus, looking out of the window, and focusing the eyes upon some distant object. This is merely an act of muscular relaxation to prevent the strain which would otherwise be caused by the continual focusing of the eyes upon near objects.

In view of the great army of the hard-of-hearing, the ears merit careful consideration. A generation ago earache, like growing pains, seemed a legitimate heritage of childhood. But the aching ear means an infection from within, from a decayed tooth perhaps, a diseased tonsil, or an infected cervical gland. The old treatment consisted of poulticing, incising, or otherwise rupturing the eardrum—a calamity in itself. Ever after the owner would carry a scarred and thickened tympanum.

In certain so-called diseases of childhood, such as measles and scarlet fever, the ears are peculiarly liable to infection. In mastoiditis the offending organism makes its way to the many blind cells of the mastoid process involving often a painful and grave operation. Home remedies have no place in an aching ear. The best doctor is needed, and the quicker he sees the case, the safer for the child. Wax sometimes accumulates in the outer ear and hardens against the eardrum. It should be removed delicately and skillfully.

Briefly stated, the hygiene of the ear resolves itself into three simple rules: Keep the ears clean, avoid injury from the intrusion of foreign objects or from roughness, and consult medical authority when there is pain or any difficulty in hearing distinctly.

Breathing.—By the process of breathing the blood acquires oxygen and discharges carbon dioxide and the body throws off moisture. Nearly all of the carbon dioxide produced in the body is discharged through the lungs and about one pint of water a day is thrown off in this manner.

The red blood corpuscles are like tiny boats hauling oxygen from the lungs to the tissues and exchanging it there for carbon dioxide which is brought back to the lungs and discharged into the air which is being exhaled. But the cargo of these boats is never limited entirely either to CO_2 or oxygen, for both gases are found in considerable quantity in either the arterial or the venous blood. It is as though our "ships" were always carrying a certain amount of

each as ballast and emptying only a part of their compartments at the lungs and in the tissues. One hundred volumes of arterial blood contain about 20 volumes of oxygen and 38 volumes of carbon dioxide. One hundred volumes of venous blood contain about 12 volumes of oxygen and 45 volumes of carbon dioxide. It seems that there is always enough of proper "cargo" at either "loading point" for the boat to take on its usual load; for a person can breathe without discomfort in air which has so much carbon dioxide that a match will not burn in it. On the other hand the rate of oxidation is not increased when a person breathes pure oxygen. Only when the blood has fallen below standard in disease or during extreme exertion does the breathing of pure oxygen have any advantage over the breathing of normal air. Here it helps to restore the standard of the blood.

The rate of breathing is not affected by the chemical composition of the air. It is controlled by the concentration of carbon dioxide in the blood through its effect upon a special regulating nerve center. Exercise, therefore, naturally increases the rate of respiration and this is the best way to take breathing exercises.

When one practices *forced breathing* he is likely to become dizzy or faint. The concentration of carbon dioxide in the blood is reduced below the point which should be maintained as a stimulus to the nervous tissues. The most immediate effect is upon the breathing center which ceases to send out the necessary stimuli, with the result that breathing is stopped or slowed down until sufficient carbon dioxide has accumulated again. Breathing sufficiently forced to produce dizziness is not to be recommended. It is well to breathe deeply at a normal rate, however, and to keep the chest expanded. Deep breathing increases the capacity and vigor of the lungs and by keeping the chest well expanded the figure is improved, the heart and great blood vessels are given sufficient room and the diaphragm is allowed a free-

dom of action which is highly beneficial to the internal organs.

Speaking.—Few people give thought to the hygiene of the voice. Yet, as a matter of fact, the quality of the voice and the health of the vocal organs are largely dependent upon proper breathing and the proper position of the body while speaking. The most common fault is "talking in the throat," that is, the continual use of the throat muscles in the attempt to modify tone and the failure to start the air movement from the diaphragm.

The common condition which the physician describes as "minister's sore throat" results from this fault. Assume the position which ministers sometimes take when they lean their elbows upon the pulpit and talk down to the congregation. You will find that the chest is contracted, the breathing restricted and the voice takes on a dull, tired, unpleasant, "throaty" quality. All this soon produces the smarting and ache of a fatigued throat.

Our friends in the legal profession, by some good chance, are favored by an arrangement by which the lawyer stands on the lowest level and looks up slightly when addressing either judge or jury. When he looks up and says, "Your Honor, my client is" etc., etc., his throat is open, his lungs expanded and his voice going up and out in an easy and natural manner. This is why the doctor rarely numbers trial lawyers among the throat cases.

The point is that the vocal cords are like the reeds of a wind instrument. The tone is determined, not by the amount of air which rushes past them, but by their state of contraction and by the shape and resonance of the air passages of the mouth and nose. When speaking is carried on with the lungs well filled, the air movement from the diaphragm, the throat relaxed and the upper part of the respiratory tract free and vibratory, the voice may be made clear and musical with adequate carrying power and without fatigue.

The difference between the proper and improper use of the voice is often to be noted in people whose tones are poor in ordinary conversation but good in sudden exclamation or in longer expressions when joyous emotion provides automatically the proper conditions for speaking. Indeed there are some people with poor speaking voices but fairly good singing voices. You can cultivate tone, carrying power, freedom from fatigue and ease in speaking by suitable attention to the proper and easy use of the organs of speech instead of the faulty and forced method of talking in the throat.

Bathing.—The first function of bathing is to keep the skin and body clean. Otherwise the skin glands will leave upon the surface solid substances which are odorous and putrescible. Cleanliness not only keeps the skin healthy and vigorous; it avoids the presence of dirt which is a possible carrier of disease; and it is directly related to the self-respect of the individual.

Perhaps something should be said of the temperature at which baths are taken. The *hot bath* opens the pores of the skin by stimulating the activity of the skin glands. It follows that its too frequent use may make the skin dry by removing the oil and that such a bath leaves the individual highly susceptible to exposure to cold. It should not be taken too often or before going out into the open air. On the other hand, a hot bath or foot bath before going to bed helps to break a cold by bringing the blood to the skin and stimulating the circulation.

If taken under proper conditions the *cold bath* is followed by a warm glow as the heat-regulating mechanism sends the blood back to the skin to neutralize the effect of cold. Such baths should not be prolonged over a minute and should be taken in a warm room when the skin is warm and followed by a good rub. They should not be taken within one hour after eating. Some find that cold baths use too much of their energy. By disturbing the circula-

tion of the internal organs they may rarely result in constipation when taken regularly each morning.

The *indifferent bath* in which the water is from 80 to 90 degrees F. lacks both depressing and stimulating effects and is a good type of daily bath for many people, particularly those who are not the most robust.

Clothing.—If the daily activities are to be performed with comfort, suitable clothing is necessary. The great essential in securing proper clothing is to provide constant ventilation for the body, that is, a continual change of the "aerial blanket." The type of clothing depends upon the nature of the fiber from which the clothing is made. The mesh of the round woolen fiber makes a cloth in which there are innumerable spaces filled with air and therefore the clothing is warm since it is not a good conductor of heat. On the other hand, cotton fabrics are made from flat fibers readily pressed together in such a way that air is excluded from the meshes. The cotton cloth therefore, allows a ready exchange of air about the body and is a good conductor of heat. Rubber fabrics are not porous at all and allow no passage of air from one side to another.

Woolen clothing is much warmer than cotton and is suitable for the person who is doing out-of-door work or riding in the open during winter weather. It is an undesirable fabric for underclothing for people who are working indoors in the city. Our offices and shops are more likely to be too warm than too cold and the perspiration of the body in such a temperature is not readily evaporated through woolen. It is absorbed by a thick woolen garment and the body does not secure the relief it should have. At the end of four or five hours in the office, however, the garment is saturated with perspiration and all of the spaces formerly filled with air have become filled with water so that the underclothing is now a very good conductor of heat and when the person emerges into the cold air the water in the garment cools and the person is chilled in his cold damp

clothes. For the man in town, therefore, it is much better to wear light underclothing and compensate for this by putting on heavy outer garments when emerging into cold air. If he is careful to walk briskly and keep up his bodily activity while out of doors or waiting for a car he has another means of increasing his bodily heat by increasing the oxidation process in the tissues.

Disorders of the Skin.—Perhaps, in addition to the discussion of bathing and clothing, we should go a step further and consider the disorders of the skin. This important organ aids in regulating the body temperature and excretes water (sometimes two quarts in a day) with small amounts of carbon dioxide, inorganic salts, urea, uric acid, and traces of albumin; it gives us contact with the outside world through the sense of touch and protects the softer tissues beneath from irritation and microorganisms. Its common disorders arise in connection with the last mentioned function, and we will do well to review skin structure briefly before considering the ailments themselves.

The outer layer of the skin, which is known as the *epidermis,* consists of an external horny layer which constantly casts off dried cells, and a deeper growing or pigment layer (rete mucosa). The latter contains the coloring matter which distinguishes the race or determines the complexion of the individual. The middle layer, *dermis* or true skin, is tough and fibrous; it serves a protective function against mechanical or thermal changes. Its numerous papillae indent the epidermis and contain tufts of blood vessels as well as touch corpuscles which serve as sensory end-organs. The third layer, *the subcutaneous tissue,* contains a varying amount of fat, and the deeper portions of hair follicles, oil glands, and sweat glands. The oil glands pour their secretion into the hair follicles, and sweat glands eliminate their contents by means of ducts which penetrate the dermis and epidermis.

A great variation exists in the texture and resistance of the skin. It may be thin, tender, easily chapped and bro-

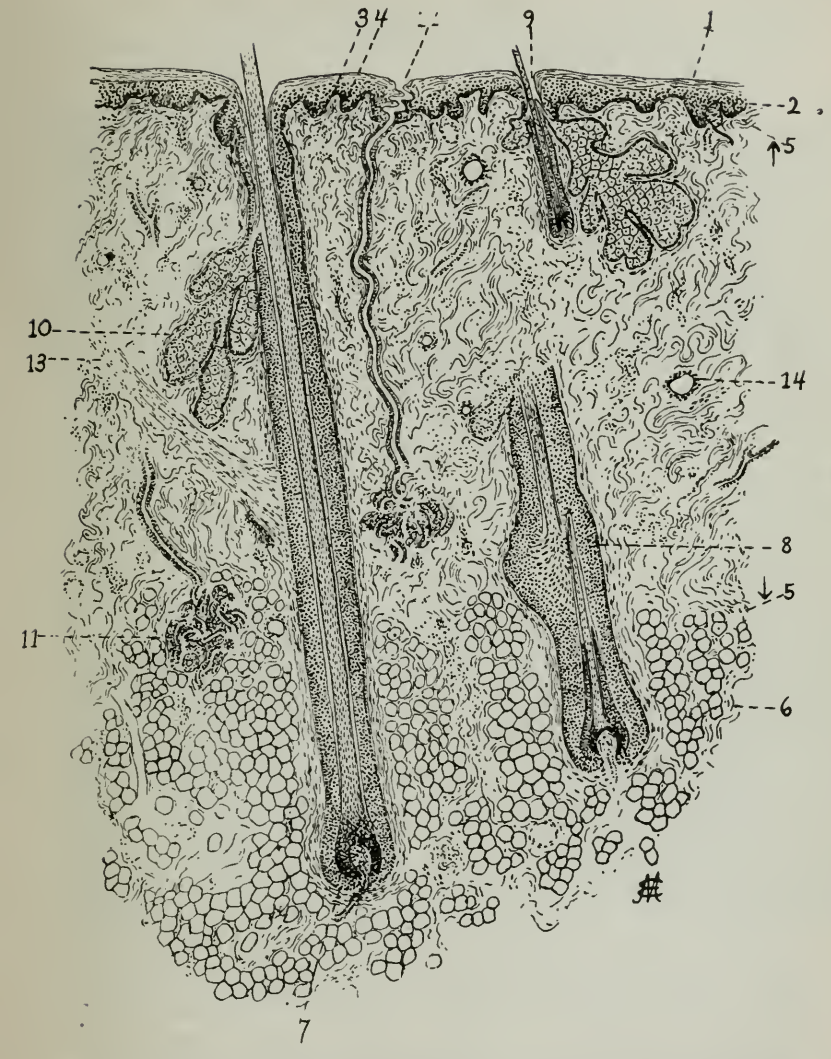


Fig. 21.—Semidiagrammatic drawing of a section of the skin from the hair margin. *1*, Horny layer; *2*, rete mucosa; *3*, papilla; *4*, interpapillary process; *5*, corium; *6*, subcutaneous fat; *7*, hair follicle; *8*, hair follicle showing root hair below and bed hair above; *9*, lanugo hair follicle; *10*, sebaceous gland; *11*, sweat gland; *12*, sweat duct; *13*, arrector pili muscle; *14*, blood vessel. (From Hazen: *Diseases of the Skin.*)

ken, or it may have quite the opposite characteristics. On account of its great extent of surface it is often exposed to infection.

A localized overgrowth of the outer horny layer produces *corns* and *warts*. These may sometimes be removed by daily application of suitable preparations, though a safe method is by knife or electric needle in the hands of a doctor.

A protrusion and undue growth of the deep pigment layer becomes a *mole*. Undisturbed, these are unlikely to cause trouble, but irritation or accident may start an abnormal growth with cancerous characteristics. Only a physician or surgeon should attempt removal.

The bane of the adolescent is *acne* with its greasy skin, blackheads (ducts choked with oily plugs of dust or soot), pimples, and often pustules. Prevention of this condition is easier than cure. A well-regulated diet of citrus and other fruits, green vegetables and whole cereals (avoiding sugars and starches) and rigid attention to the bowels are indicated. Cleanliness, internal and external, is essential. The individual should drink plenty of water and keep the skin scrupulously clean with soap and hot water. Hot applications alternated with cold will stimulate a vigorous circulation and more active elimination in the skin.

Boils often arise from tampering with pimples. They are produced by an infection of the hair follicle with bacteria (usually staphylococci) which are introduced from without more often than from within. They should be protected with sterile cotton or gauze in order to prevent an extension of the infection. A high blood sugar increases susceptibility to boils and physicians usually advise eating less starch and sugar. Heat is usually applied while a boil is developing to soften it and bring it to a head. When this is accomplished and pus formation is complete, the boil is opened and dressed with the usual surgical precautions.

Ringworm is caused by the growth of a fungus (mold) on the skin. It is often found on the face or body of the school

child. "Barbers' itch" is a form of ringworm which is sometimes passed from one person to another by unclean barbers' implements. Gymnasium clothes which are not

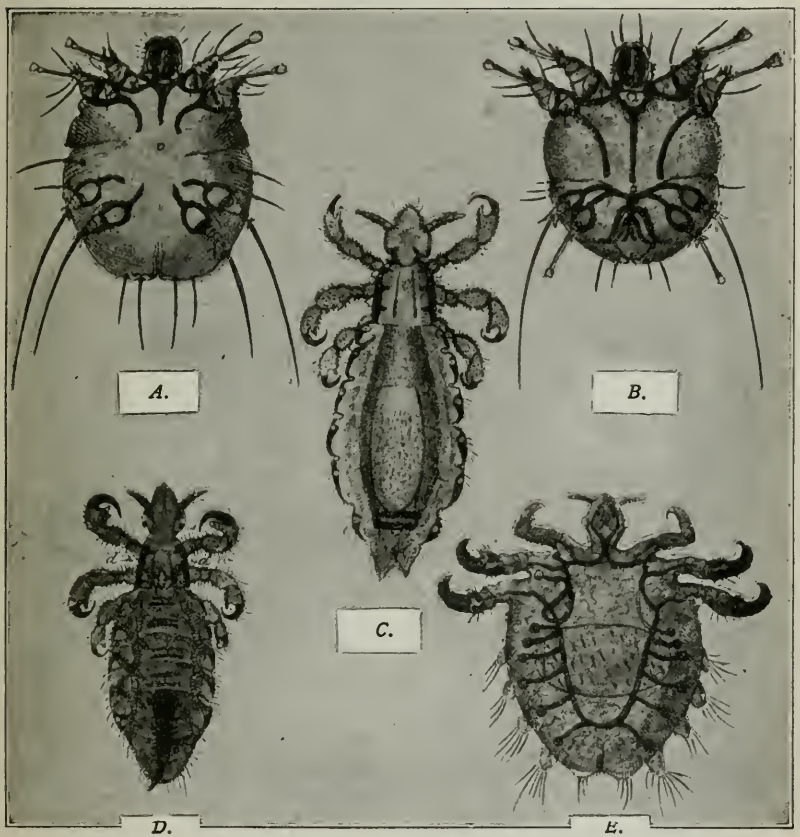


Fig. 22.—Animal parasites. *A*, Sarcoptes scabiei, female (ventral surface); *B*, Sarcoptes scabiei, male (ventral surface); *C*, Pediculus corporis; *D*, Pediculus capitis; *E*, Pediculus pubis. (From Sutton: *Diseases of the Skin.*)

thoroughly dried allow the growth of mold and sometimes transfer it to the skin of the wearer.

Scabies is caused by an insect, the itch-mite, which is too small to be seen with the naked eye. Its prevention is

largely a matter of cleanliness, but its progress is difficult to control, especially in winter, when heavy underclothing and bedding offer endless breeding places. The mite burrows under the tender skin between the fingers of unhappy victims. It often spreads to other areas of the body.

Pediculosis is a result of the infestation of some part of the body with one of the three forms of lice which are parasitic upon the skin of man: the head louse, the body louse, or the pubic louse. These vermin get onto the body from infested persons themselves, their clothing, or their personal effects. Pediculosis of the scalp is the most common form. Severe itching of the scalp is caused by the bites of the insects and subsequent infection. The eggs or nits of the louse are attached near the base of the hair shaft. A remedy which is commonly recommended is the rubbing of the head thoroughly with equal parts of kerosene and vinegar, and binding it overnight with a towel. The next morning the head is washed in hot suds and, after the hair dries, the nits are brushed out.

The body louse lives upon the blood of man but spends its time in the seams of his clothing rather than on his skin. This insect has been found to transmit the germ of typhus fever, so that the sterilization of clothing and other measures to prevent the infestation have become important military measures.

Infestation with the pubic or crab louse is the least common of the three types.

CHAPTER V

THE HYGIENE OF THE CENTRAL NERVOUS SYSTEM

The proper care and conservation of that exceedingly complex machine, the central nervous system, upon which depend the sensations of consciousness and the efficiency of our mental and physical activities, is highly important.

Function.—Through physiology and anatomy we early learned of it as a telephone-like system of communication having the central station in the brain, from which orders are constantly being sent during our waking moments, and having substations in our reflex and sympathetic nervous systems which are capable of handling minor emergencies flashed in as impressions from those parts of the body connected with each substation. The higher centers are subject to a continual bombardment of impulses and stimuli from the sense-organs.

This is a system composed of living substance which demands rest between periods of great activity and like other living tissues it increases, through use, its facility in the work it has to do. But if it is *overused* or *abused* it becomes hypersensitive. Stimuli which ought not to go beyond the substations are flashed through to the head station and trifles interfere with important activities. The person is irritable and the system is unable to carry out its normal functions.

Without taking time to review the structure or function of the system in detail we shall consider the hygiene of the nervous system first in health and later in disease. It is common experience that the nervous system becomes tired at the end of the day's work. We know that the activities of the normal life place demands upon it which must be compensated by periods of rest. Our interest here concerns the

efficient functioning of the nervous system and the important ways in which rest and efficiency are secured by the normal and healthy individual.

Concentration.—Perhaps the most important characteristic of the efficient nervous system is the power of concentration upon the task at hand. This is expressed in another way as the power of inhibiting undesirable stimuli. It is equally valuable in work and in rest. In work the individual inhibits from the center of consciousness those thoughts which are not germane to the subject in hand and also those stimuli which arise from the surroundings, trying to make their way to the center of consciousness through the portals of sight, hearing, touch, and perhaps taste and smell. In the efficient mind such stimuli and the inconsequential thoughts which arise from their associated ideas are rigidly excluded from the conscious thought.

Recreation has the reverse process and the individual severely forbids thoughts and worries of his work to crowd in upon the enjoyment of the pleasures which he has allowed himself. For those people who, like great executives, are obliged to shoulder heavy responsibilities and are weighed down with numerous cares, the power of complete relaxation may be a saving grace. The criticism which has sometimes been placed upon Lincoln and other men of this type for brief periods of light-heartedness in the midst of great problems is entirely unjust and unreasonable.

The power of concentration is so intimately linked with efficiency and personal success that one may well ask how it may be secured or improved. Perhaps the most valuable aid is good health, for with it the body is freed from minor pains, irritations and morbid sensations which are constantly breaking into the train of thought of the physically unfit, opening the way for other distracting influences.

Fondness for one's work is another important factor, since the work itself is making a constant appeal to the mentality and the volition. That is why there is a unity between the

things people like to do and the things they do well. The arrangement of one's workshop or desk in such a way that but one thing at a time is before the worker is important, and often it is of material assistance to occupy the hands with a pencil in making notes or sketches or with models, apparatus or instruments in studying technique. A man will do well to study the lighting, furnishings and equipment of the work place to eliminate distracting stimuli such as might arise from the reflected light of a glossy page, uncomfortable chairs or confusion of material.

Habit.—Habit is another important factor in the conservation of the nervous system. The processes of eating and dressing are exceedingly difficult for the young child, but by the adult they can be accomplished while the mind is devoted to a more pleasant plane of thought than the necessary mechanical operations which are being performed. In the same way many activities connected with the daily work may be relegated to the realm of habit and thus the energy of the nervous system may be spared. Energy-saving habits are highly desirable.

But apart from this psychologists have pointed out a group of so-called indifferent habits like the continual use of particular words and phrases, the lack of reasonable variety in dress and recreation. They have pointed out that old age is a fixity of the nervous system which such long-continued habits have limited to particular channels of thought and action. If this is true it is possible to postpone old age by occasionally breaking up these habits in a determined fashion and freeing the mind from ruts.

Sleep.—To the normal person sleep is the great refreshing agent for the nervous system. The nature of this invaluable process still awaits complete explanation. There are two other types of unconsciousness; namely, intoxication by drugs, in which sensations are blocked from reaching the central nervous system, and fainting, where consciousness is lost be-

cause of an insufficient blood supply in the brain. Perhaps sleep has an element of both these types of unconsciousness, involving an altered brain circulation and the accumulation of the poisonous waste of bodily activity.

The unconsciousness of sound sleep carries with it the complete relaxation of the body. This is the time when the body tissues make good their losses and for these reasons no satisfactory substitute for sleep can be found. It is probably this complete relaxation and its accompanying reduction of oxidation which makes a person chilly upon falling asleep in his chair or upon the couch in a room which has previously seemed warm enough.

No doubt other factors than nervous fatigue are important in determining the amount of sleep required, since it varies greatly in individuals and is markedly greater in the young than in the old. Perhaps the most important factor here is assimilation. Heavy eaters are characteristically heavy sleepers, whereas "Fletcherites" testify that the great reduction in the amount of food eaten and the completeness of its mastication has reduced the amount of sleep which they find necessary.

Eight hours of sleep is enough for the average normal and healthy adult person; but the amount of sleep needed varies widely among individuals. The thin and nervously exhausted adult may find that an extra hour of sleep or an afternoon rest period is indispensable. It has been found by experiments that during the first two hours sleep is the heaviest and after that the person is waked more easily. This does not necessarily mean that the later hours of sleep are not equally restful but merely indicates that the nervous threshold has been lowered by the rest already secured. Brain workers rather than manual laborers are likely to suffer from too little sleep.

The difficulties in going to sleep promptly and in sleeping soundly do not usually exist for the normal individual if he is physically tired. Wakefulness often seems more serious

than it really is because the person may hear the clock strike regularly but yet obtain several hours of light and dozing sleep. Apart from physical exercises which induce bodily fatigue and secure a healthful sleep it is sometimes possible to avoid sleeplessness by the eradication of disturbing factors. The bed should be comfortable, the room dark and quiet, and the ventilation adequate. The person who sleeps where there is continuous noise, may say that he can sleep soundly, but he is probably doing his nervous system an injustice nevertheless, because he is partly wakened several times during the night. The absolute banishment from the mind of exciting and worrying thoughts, the persistent reflection upon inconsequential and humdrum things, the complete relaxation of all muscles including those of breathing, may also aid a person in promptly falling asleep.

The accompanying graph (Fig. 23) shows in an interesting manner the relationship between the amount of sleep one gets and one's working efficiency. The data are taken from a study of rest pauses and employee effectiveness made by the Western Electric Company. In this research, with which the author was associated, we first compared the output for individual days with the number of hours of sleep obtained the night before. Frequently, but not always, a small amount of sleep was associated with a somewhat lower output. It was obvious that sleep is not a primary or dominating factor in determining output. The graph, which was made up from averages obtained by securing data over a period of several months, clearly shows that sleep is, however, a measurable factor in determining a person's productivity.

These data were taken from a group of five young women assembling relays, a light manual, bench operation, requiring dexterity. The analysis of data for each individual worker brought out another interesting fact. Each of the girls had an appreciably higher output on the average for

days following eight to ten hours sleep than for days following five to seven hours sleep; but some girls were able to withstand loss of sleep much better than others so far as reduced working capacity was concerned.

Dreams.—The subject of dreams suggests itself. We must leave their philosophy to the psychologist, limiting ourselves to

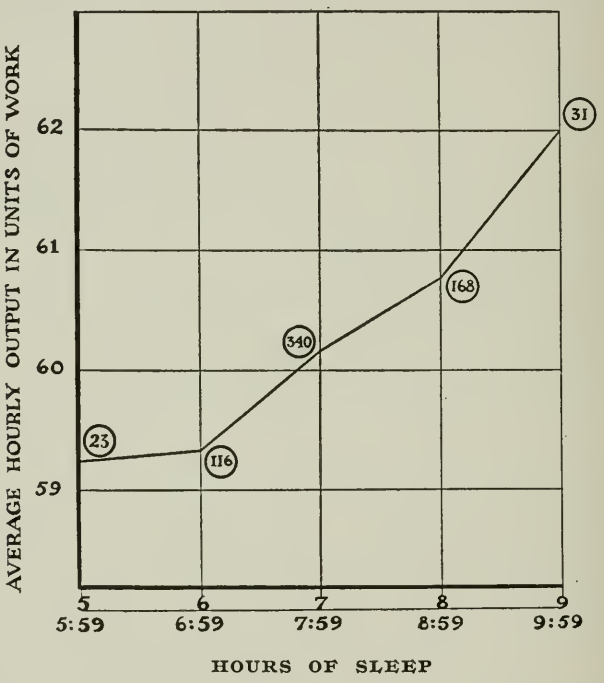


Fig. 23.—Graph showing the relation between the number of hours of sleep obtained by factory employees doing light manual work and the output for the following day. (Courtesy Western Electric Co.)

a brief statement of their importance from the hygienic viewpoint. There are two types of dreams, the remote and the recent. The remote type deals with experiences widely separated from the activities of the day, the other type deals with the worries and problems of our waking hours. It is the

latter and not the former which should be a warning to us that our nervous system is not in a rested and normal condition.

Change of Work.—Another method of resting the nervous system is by a change of work which puts in play a wholly different set of nerve structures. The man who has worked over a machine all day and is thoroughly tired may rest his nervous system as well as refresh his muscular system by playing baseball or tennis, but one must be careful, in this connection, not to commit the fallacy of assuming that nervous excitement, when it involves the nervous structures already tired, is rest. The man who is tired from driving an automobile may forget his weariness by watching a moving picture of hairbreadth escapes; but he is not rested thereby and it is only the strong stimulation of the overtired nervous structures which causes him to forget his fatigue temporarily. It is probably unfortunate for the nervous system as well as for family life that the habit of quiet home reading has been abandoned for a variety of exciting social amusements.

Sunday Observance.—Sunday observance is a most important safeguard for the nervous system. In some experiments carried out at the Harvard Medical School (reported by Martin, Withington and Putnam, *American Journal of Physiology,* Vol. XXXIV) it was shown that the sensory threshold, as measured by the least electric shock which could be felt through two fingers of the same hand, was lowest on Monday and highest on Saturday. In other words, the irritability or sensitiveness of the nervous system was highest after the day of rest or change in activity and was gradually reduced throughout the week. Apparently there is a cumulative fatigue of the nervous system by the work of the day which is only offset by Sabbath rest. This may account physiologically for the fact that one day in seven has been set apart by people of nearly all races and religions as a day of rest and worship. It is certain that the observance of Sunday as a day

of quiet when, for a time at least, the thoughts may be fixed upon immortal truths and upon things entirely separate from the struggle of the week is much to be desired in the care of the nervous system.

Neurasthenia.—We have considered the care of the nervous system under the normal conditions of life and may now turn our attention to a discussion of an abnormality of the nervous system which is to some extent preventable and remediable. Neurasthenia is a condition manifesting itself by a loss of emotional control. The patient becomes concerned or excited over trivial causes. He loses the poise and balance which have heretofore enabled him to meet the emergencies of life. He becomes self-centered, secretive or voluble, and exaggerates or distorts to his own detriment, hitherto amicable relations with his fellows.

The underlying cause of the disease is obscure. There is occasionally a history of alcohol or syphilis. Often it occurs in a neurotic family, thereby suggesting a taint of heredity. On the other hand, neurasthenia commonly attacks the "light-weight," thereby revealing the lack of vigor and resistance to be expected in a poorly nourished nervous system.

The exciting cause may be gradual, as the constant wear and tear of an unhappy home upon a sensitive, maladjusted child; or it may be the sudden nerve explosion shown by men under stress of the horrors of war. These cases may respond to better hygiene and happier surroundings, to suitable occupation and kindly understanding.

Overwork.—By overworking the mind, we mean putting too great a tax upon its endurance and not a too strenuous endeavor to concentrate the mental faculties. It is a case of too long hours and not too vigorous mental work. There is a maxim for students in regulating their hours of work that "8 plus 2 equals 10 but 10 plus 2 equals 8" when measured

by the effective work done. In other words, there is a time limit in taxing the nervous system.

Emotions.—The discussion of emotion in previous chapters has already suggested that not work but worry is harmful. The effects of the emotion upon the central nervous system are varied and important.

If we trace the initial difficulty of indigestion due to the emotions, we find that the food lies in the stomach into which no digestive juices have been poured until abnormal and harmful decomposition changes begin to take place. Then as the food is finally passed into the intestines there is further decomposition because the protein digestion has not proceeded to a suitable degree in the stomach, and the bacteria in the intestines decompose food substances into soluble and harmful end products, which are absorbed from the walls and produce that mild poisoning known as autointoxication. These deleterious compounds have a specially marked effect upon the central nervous system. Autointoxication may be produced by such continued unfavorable emotions as worry, fear, grief and pity, and it is increased by overeating, especially the overeating of nitrogenous foods. It is one of the important factors in deranging the nervous system.

The emotions have other relations to the nervous system than those connected with digestion. As Cannon clearly showed, the emotions were designed as an aid to activity, by increasing the amount of sugar in the blood, producing a marked secretion of adrenalin, bringing digestion to a halt and increasing the capacity of the skeletal muscles. It is normal and probably more beneficial to the individual when his strong emotions find an outlet in action, for then the impulses are translated into muscular activity. The external bruises of the school boy who fights are perhaps not as serious as the internal injury to the nervous system if there is no outlet for his anger. Even when a person has remained in-

active there is some energy resulting from emotion or excitement, for these stimuli, upon reaching the muscles produce balanced contractions which may be indicated by tenseness of the muscles and features.

It would seem therefore that for the normal and especially for the sluggish individual a reasonable amount of emotional excitement may be harmless and even desirable. But in so far as environment may be regulated to eliminate constant and undesirable emotions this should be done and whenever possible our emotions should be given a physical outlet, especially those noble emotions which are produced by beautiful music and other forms of art, by the glories of nature, and the eloquence of gifted speakers. These stimuli should be translated into practical beneficent action.

Bodily Defects.—There are many bodily defects which injure the central nervous system to a large degree. We remember that pain has the same effect upon many organs of the body as do rage, fear and anxiety, and it seems reasonable that many mild bodily ills, which are tolerated when they should be corrected, will create continuous and harmful sensations in the central nervous system. Decayed teeth, troubles of the feet, such as fallen arches, ill-fitting shoes, corns and blisters, the wearing of orthodontia appliances by children, nasal obstruction with tonsillar and adenoid trouble, hemorrhoids, and uterine displacement are examples of conditions which should receive prompt attention not only for their own sake but for the injury which they do the nervous system.

Eye strain is another important example. The nearsighted individual who is trying in vain to focus the eye, which is too deep, in such a way that normal vision shall be effected; the farsighted individual, who must put an extra strain upon the eye to focus it for near objects; and the individual with astigmatism, who is always straining the eyes in the attempt to secure a clear image, are all bound to feel the effects upon the nervous system. On the other hand the correction of these

difficulties often makes a new man or woman so far as temperament and congeniality are concerned. Perhaps it is the duty of the family to insist that such conditions are corrected for, after all, they have to live with the afflicted, and may have some rights in the matter.

Stimulants.—Stimulants also should be considered in their effect upon the nervous system. Physiologists now agree that *alcohol* is not a stimulant but a narcotic. The reason for the feeling of exhilaration which follows a mild dose of alcohol is due to the paralyzing of the higher centers which have to do with inhibition. When these centers are shut out from the rest of the nervous system the individual no longer feels the restraint of dignity and propriety. He gives free rein to his impulses and believes himself to be the soul of wit and the prince of goodfellows even when his activities are most asinine. As Professor Stiles has suggested, alcholic stimulation is like taking the brakes off on a train which is traveling down hill. It is easy to reach the lower level but it is hard to regain the heights.

In a study of the intellectual capacity of a group of students before and after using alcohol the subjects were given certain simple mathematical problems which were accomplished in a given time and the amount of errors checked. Later in the day after having partaken of small quantities of alcohol, the students were given similar problems to do and upon emerging from the room all testified that they had done the work more quickly and rapidly than in the first instance. The actual results were different from their expectations, however. They had taken longer to do the work and had been less accurate. The temporary banishment of care and the sense of obligation for the moment is a pleasure and may make the individual a more gracious social being but the resumption of responsibilities after the taking of alcohol is not so easy, and good health rather than this alternative should be the basis of our social graces.

Many of the *patent medicines* have been shown to have an alcoholic content greater than champagne as the following table shows:

ALCOHOL COMPARISONS

Beer	4½%
Ale	8%
Champagne	10%
Swamp Root	9%
S. S. S.	15%
Varnesis	15%
Pinkham's Vegetable Compound	15%
Warner's Safe Remedy	15½%
Tanlac	16%
Pepto-Mangan	16%
Hood's Sarsaparilla	16½%
Vinol	18%
Manola	18%
Wincarnis	19%
Paine's Celery Compound	19⅘%
Peruna	20%
Wine of Cardui	20%
Plant Juice	20%
Hostetter's Bitters	25%

It may not be inappropriate therefore to classify such substances as stimulants especially since in many cases their real medicinal value is seriously in question. The man who is foolish enough to prescribe such a remedy for himself instead of seeking the advice of a good physician for his ills, ought to know what it really is which makes him "feel better" when he drugs the system with a patent medicine cocktail.

Tea and *coffee* are not narcotic but are true stimulants and their effect on the body is to increase activity. For most adults their use in reasonable quantities is not harmful. There are people, however, who find that one or the other of these drinks is a definite injury. To be of greatest value they should not be used regularly but only when some unusual demand is to be placed upon the nervous system. Coca cola is also a caffeine-containing drink.

CHAPTER VI

THE HYGIENE OF REPRODUCTION

The Problem Defined.—The problem of reproduction in its broadest sense involves the replacing of one generation by another in the best possible manner. This includes compliance with the laws of heredity, a knowledge of the effects which the conduct of life may have upon the offspring, the best possible supervision over the hygiene of pregnancy and the early days of infant life, and the proper regulation of the sex life.

HEREDITY

Our knowledge of heredity has expanded rapidly during the past few years. We have here, however, only sufficient space to mention some of those facts which are important in guarding against the perpetuation of undesirable traits and physical conditions in offspring. The development of the subject has come from two lines of study, researches upon human heredity (eugenics) begun by Galton and researches in plant and animal breeding (genetics) begun by Mendel.

Mendelian Inheritance.—Mendel's law enunciates the principle that opposing characteristics in the male and female parents do not blend in the offspring but the heredity units or genes remain distinct in the germ cells of the offspring recombining in future generations according to the law of probability and chance.

To illustrate by an example from Mendel's work: when a pea plant which produces peas having a green color is crossed with one producing peas of yellow color all the peas produced in the first generation are of a yellow color but if plants of this first hybrid generation are crossed among themselves the peas produced in the second generation are in a definite ratio of three yellows to one green.

This law may be illustrated also from animal heredity. Among guinea pigs the crossing of a black strain with a white strain produces in the first generation only black offspring but if these pigs are bred among themselves the resulting offspring are in the ratio of three black pigs to one white one.

These results are most clearly understood in terms of the presence and absence theory which assumes that the yellow pea and the black guinea pig possess factors in the germ cell for yellow and black color, respectively, and that these color factors are lacking in the green pea and the white pig. Such

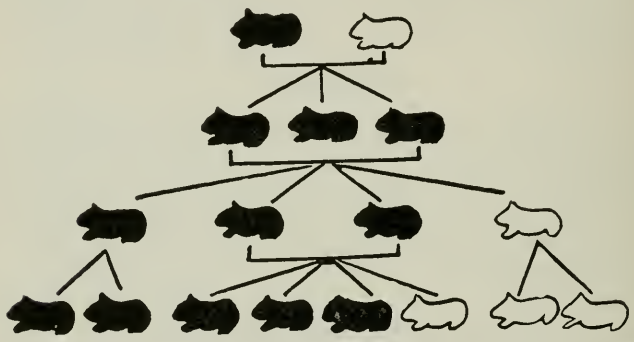


Fig. 24.—Inheritance in guinea pigs showing where the color (black) dominates over another color (white). (Kelicott.)

a characteristic appears whenever it is present in one or both of the germ cells united to create the new individual. We have here an explanation of the fact that offspring of the first generation all show a particular characteristic which has been inherited from one of the parents. We call such a characteristic as blackness in the guinea pig a dominant characteristic and the white color a recessive characteristic. The diagram on this page illustrating the inheritance in guinea pigs shows why the first generation is completely black. All of the ova produced by the female guinea pig contain the characteristic for blackness and although they are united with sperms which lack this characteristic for blackness they still

carry the characteristic to the fertilized egg which is the beginning of the existence for the new individual.

It may help us to understand the law better if we consider the explanation afforded by the general belief that the chromosomes are bearers of the hereditary characteristics. The reader will recall from elementary studies of biology that the chromatin or deeply staining substance of the cell nucleus arranges itself into short threads called chromosomes whenever there is a cell division. The number of these chromosomes is constant for any species of animal. The number in all of the *body* cells is twice that in the mature *sex* cell. In other words, the final maturation processes of sex-cell development allow a separation of the chromosomes into two sets or groups so that there *may be* two kinds of sperms and two kinds of ova so far as the inheritance or non-inheritance of any characteristic is concerned.

Returning to our example of the inheritance of color in guinea pigs we assume that the black color is produced by a special factor for pigmentation which is present in the sex cells of the black pig and absent in those of the white pig. It would appear that this factor is present in a chromosome inherited from the female parent but absent in the corresponding chromosome inherited from the male parent. It would therefore be present in all of the body cells of the hybrid but when this pair of chromosomes again become separated in the production of sex cells they would produce cells of different types. Therefore, we may have from this generation of hybrids, ova containing a factor for pigmentation and ova lacking the factor for pigmentation. Likewise, we may have spermatozoa with this factor and others without it, so that there are four possibilities in the mating of cells within the uterus which must be in reality a matter of chance. The female cell with the character for blackness may unite with the male cell also having that characteristic and in that case the offspring produced receives the same inheritance from both parents so far as this characteristic is

concerned, and therefore it is a "pure black" which will always produce black offspring. There is an exactly opposite possibility, namely, a union of two cells neither of which has the characteristic for blackness. Such a union results in a white pig of pure stock so far as color is concerned.

Two other possibilities involve the mating of a *female* cell *containing* the characteristic with a *male* cell *lacking* the char-

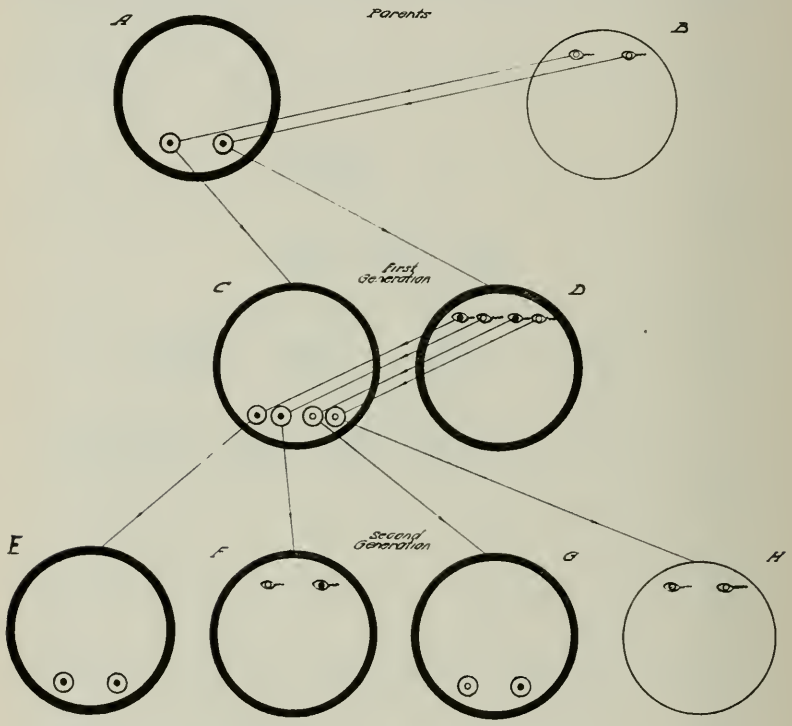


Fig. 25.—Diagram illustrating the mechanism by which the unit factor, color, is inherited in guinea pigs. Animal *A* is a black female of pure stock. Such an animal is called homozygous and all of its sex cells are alike in carrying the unit character in question. Animal *B* is a homozygous white male; none of the sex cells have the characteristic for blackness. Animal *C* (female) and *D* (male) are hybrids. In each case half of the sex cells carry the characteristic for blackness and half of them lack this characteristic. When *C* and *D* are crossed the offspring of the second generation are in the ratio of three black to one white. The diagram illustrates each possible chance-combination of sperm and egg and it will be seen that, of the second generation animals, *E* is homozygous, *F* and *G* are heterozygous like *C* and *D*, and *H* is a homozygous white.

acteristic or the exactly opposite condition. In either case we have a hybrid individual like the parents, that is, one and only one of the pair of chromosomes with which the color

Fig. 26.—Eminent Twins. Edwin P. Grosvenor (left), prominent New York lawyer, and his twin brother Gilbert Grosvenor (right), President of the National Geographic Society. (Photograph from Gilbert Grosvenor.)

factor is connected contains the characteristic. Such animals are black in color because a pigment factor is present, although only in half quantity, and if again bred among them-

selves we once more have a 3-1 ratio, that is, three black offspring to one white. Naturally since this ratio depends upon probability or chance it is not exact. However, the greater the number of offspring the more exact is the ratio. This three to one ratio is in reality a ratio of one pure black: 2 hybrid blacks: 1 pure white. Such an hereditary trait as the one just described is called a unit character.

The study of genetics has taught us that many characteristics are inherited like the unit factors mentioned above. That being the case, it is obvious that these characteristics can be mingled by crossing different types and can be recombined in new combinations. For example, it might be possible to cross a round red tomato with a yellow pear-shaped tomato and by continued breeding and careful selection secure a pure strain of red pear-shaped tomatoes. This indeed is the principle and the explanation of the wonderful work accomplished by Luther Burbank in plant breeding.

We can but marvel at the miracle of nature displayed in heredity. From each mating of sex cells, all of which look exactly alike when viewed with the highest power of the microscope, nature produces an individual different in characteristics from any other of the millions of people who inhabit the globe. It is difficult to explain how so many characteristics can be arranged spacially in the tiny germ cell unless we can conceive that these characteristics are caused by the infinite varieties in molecular pattern which are possible in the highly complex chromatin substances.*

The mechanism of inheritance is in no way better illustrated than in the complete similarity of identical twins which result from the separation of the embryo in its two-celled stage.† Such twins must therefore receive identical hereditary factors. Compare the records of the Grosvenor twins. As stu-

*Miescher has shown that a molecule of albumen with forty carbon atoms may have as many as one billion stereoisomers, in protoplasm there are many kinds of albumen and other proteins, some with probably more than 700 carbon atoms.—*Conklin.*

†Fraternal or unlike twins are produced from separate eggs, each of which is fertilized by a sperm cell.

dents at Amherst College they divided highest honors in the classroom and on the tennis field. Both have since achieved distinction, one as builder and director of the National Geographic Society, and the other as Assistant Attorney General and partner in one of the most important law firms in America. They have never varied more than a pound in weight. In college their grades never varied more than one-tenth of one per cent. Although absolutely dependent upon glasses, each can wear the other's. Most of their tastes are similar.

How Sex in the Offspring Is Determined.—There has always been considerable speculation as to how sex in offspring is determined, because the question is of vital interest to parents who have a preference for either a son or a daughter; and it is interesting to find that the explanation offered by Mendelian studies in heredity and the microscopic studies of cell structure, which have for the most part been developed by Morgan, Wilson, and other American investigators, indicate that sex in the offspring cannot be controlled. We said previously that the body cells of animals contain twice as many chromosomes as do the sex cells. We must modify this general statement by saying that in the male of certain species this is not true. In such animals, of which it seems that man is an example, there is a chromosome which students of heredity speak of as the sex chromosome.

Investigators believe that among humans all body cells in the female contain 48 chromosomes. This is true of the sex cells up to the time of the maturation process when the reduction takes place and the ripe ova are found to have 24 chromosomes. Among males the body cells appear to contain 47 chromosomes and when the maturation process takes place the odd chromosome or sex chromosome as it is called goes to but half of the cells resulting from the last division. We therefore have two kinds of spermatozoa in man, one having 23 chromosomes, the other having 23 chromosomes plus the sex chromosome or 24. When the 23 chromosome sperm

unites with the egg we have the beginning of a new individual of 47 chromosomes or a male. When the 24 chromosome sperm unites with the egg we have a new individual of 48 chromosomes or a female. Femaleness, then, is produced by the presence of two sex determiners, that is, it is an added characteristic superimposed upon maleness. The determination of sex is therefore a matter of chance.

Sex-Linked Characters.—Apparently the causative factors of certain other characteristics are located in the chromosome which determines sex and such unit characters are called

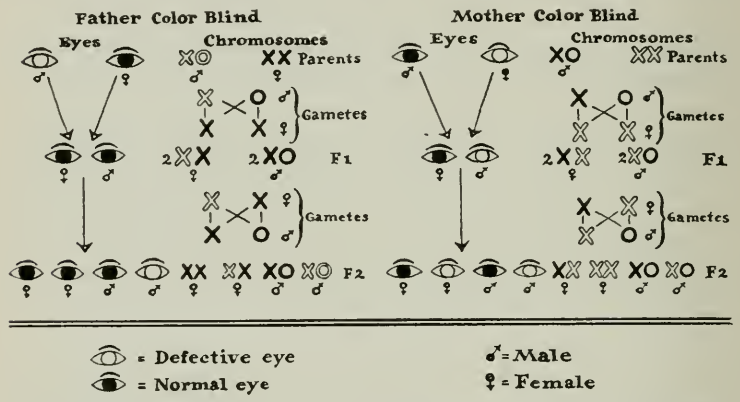


Fig. 27.—Transmission of color blindness. The left half of the chart shows that a color-blind man transmits his defect to his grandsons only. The right half of the chart shows that a color-blind woman transmits her defect to all of her sons and to half of her grandchildren. *X* is used to represent a particular chromosome which bears the inheritance of sex. The male is believed to have one of these sex chromosomes, the female, two. In normal persons this chromosome carries a unit factor which produces normal color vision. A color-blind person has not received this unit factor in either the male or female gamete.

sex-linked. Remembering the nature of the sperm cells described above, we see that a sex-linked character in a man might be transmitted to his daughter but not to his son, if it were a dominant character. If it were a recessive character it could not be transmitted to any of the children from the father provided the mother were normal in this respect. Recessive sex-linked characteristics when transmitted by the mother would be apparent only in the sons.

Color blindness gives an example of this kind of inheritance and since it is a recessive characteristic, a color-blind man need have no fear of transmitting the defect to his children if he marries a woman with no taint of this defect. This defect, however, may be passed on through his daughters to his grandsons but not to his granddaughters. The color-blind woman on the other hand if married to a normal man even though she inherited color blindness from both her parents would not transmit the defect to her daughters. Her sons, however, would all be color blind. The fact that this characteristic is located in the sex chromosome explains why color-blindness is more common in men than in women. Being recessive it is not apparent in the female unless it is inherited from both parents, while in the male it is directly received from the mother since it is not counter-balanced by a normal inheritance from the father.

Inherited Diseases and Abnormalities.—There are several unit characters which have already been discovered in *human heredity.* Some of these are diseases but fortunately for the race these diseases are usually recessive and their evil effects may be counteracted by intermarriage with a normal stock. In other words, any disease due to a recessive hereditary character will not develop if a normal inheritance in this respect is received from either mother or father.

The accompanying table shows some of the conditions in man which are inherited according to Mendelian principle.

MENDELIAN INHERITANCE IN MAN

(*Teratological and Pathological Characters*)

Dominant	Recessive
GENERAL:	
Achondroplasy (Dwarfs with short stout limbs but with bodies and heads of normal size)	Normal
Hereditary fragility of bones	Normal

HANDS AND FEET:	
Brachydactyly (short fingers and toes)	Normal
Syndactyly (Webbed fingers and toes)	Normal
Polydactyly (Supernumerary digits)	Normal
Symphalangy (Fused joints of digits, stiff digits)	Normal
SKIN:	
Tylosis and ichthyosis (thickened or scaly skin)	Normal
Epidermolysis (Excessive formation of blisters)	Normal
Dark	Blonde or albino
Spotted with white	Uniformly colored
KIDNEYS:	
Diabetes insipidus (Excessive production of urine)	Normal
Normal	Alkaptonuria (Urine dark after oxidation)
NERVOUS SYSTEM:	
Normal	Friedreich's Disease (Degeneration of upper part of spinal cord)
Huntington's Chorea	Normal
Normal	Hereditary feeble-mindedness
EYES:	
Front of iris pigmented (eye brown, black, etc.)	Only back of iris pigmented (eye blue)
Normal	Pigmentary Degeneration of Retina
Glaucoma (Internal pressure and swelling of eyeball)	Normal
Coloboma (Open suture in iris)	Normal
Hereditary cataract	Normal
EARS:	
Normal	Deaf-mutism (certain forms only)
Normal	Otosclerosis (Thickened tympanum with hardness of hearing)

(*Sex-Linked Characters*)

Recessive characters, appearing in male when *simplex*, in female only when *duplex*.

Normal	Gower's Muscular Atrophy
Normal	Haemophilia (Slow clotting of blood)
Normal	Color Blindness (Daltonism; inability to distinguish red from green)
Normal	Night Blindness (Inability to see by faint light)

It is believed by some investigators that many other characteristics relating to normal variations of the hair, eye, skin, countenance, temperament, intellect and nervous system are inherited in Mendelian fashion. It is difficult to secure evidence in human heredity and the way in which many of these characteristics are inherited is still in doubt.

Mentality and Heredity.—The importance of good heredity has long been realized in characteristics or combinations of characteristics where the Mendelian principle is not present or where it has been impossible to demonstrate it. A case in point is the inheritance of mental equipment. Mental ability is without doubt inherited as there is a high correlation between the mentality of fathers and sons, and between the mentality of brothers. There is also a high correlation between the mental abilities of husbands and wives since there is usually selective mating through which men choose wives like themselves in mentality. (In contradiction to a popular belief most people marry "likes" not opposites.) This helps to raise the father and son correlation.

The inheritance of mentality is not like the inheritance of a dominant or recessive unit character. In mentality, physical stature, size and some other characteristics the offspring of widely different parents seems to be intermediate between

the two. It would seem that there is either a blending of characteristics or else the quality in question is produced by many or "multiple" unit factors. In the latter case if the father possessed twenty factors for mental ability and the mother ten the offspring would receive about fifteen and would therefore be intermediate in condition thus giving the appearance of "blending inheritance."

Of course the question of environment enters here since children of most brilliant parents would have the best surroundings. It is not possible to give a general answer to the question as to which is the *more* important, heredity or environment. Color blindness is due to heredity; voice, speech, manners and indeed business success may be due to environment. There is good evidence of the importance of heredity, however, in the production of essential mental and physical traits like long life and good constitution. For example, Dr. F. A. Woods has shown that the correlation between father and son in attaining distinction is as high in America as in the old countries of Europe. Now if success were entirely a matter of environment or "equal chance" there would be a lower correlation in America where, as in a young country, the opportunities are much more nearly equal than in the old countries with established castes. The "little red school house" *cannot* "give every boy an equal chance to be president." All men may be "created free" but they are not all "created equal."

Dr. Woods has shown that if the people in the Hall of Fame on the Hudson were stood in line with the first beneath the center of the dome in the capitol at Washington the line made by the thirty would not reach outside the room. If the people of distinction as recorded in standard biographical dictionaries were stood behind them the line would reach outside the capitol and be continued for a mile or so down Pennsylvania Ave. If their contemporaries (the remainder of the American people) were stood in line behind them the line would stretch to Chicago, on to San Francisco and up to Alaska. Of the last

group one in 500 would be closely related to a man of distinction, of the middle group one in four would have a near relative of distinction and of the first group the people would average one such near relative apiece. Apparently there are "good strains" of human stock.

Contrary to popular tradition it seems that the often maligned sons of clergymen stand a chance of vindication. A greater proportion of clergymen's sons are to be found in *Who's Who in America* than sons of any other professional or laboring class, skilled or unskilled. Statistics appearing in *The Builders of America* by Ellsworth Huntington, Yale social scientist, and Leon F. Whiting, eugenist, show that for every twenty clergymen one clergyman's son is listed in *Who's Who,* whereas the proportion for other professions is 46 to 1; for skilled labor 1,600 to 1; for unskilled labor 48,000 to one. Famed sons of clergymen include Henry van Dyke, William Lyon Phelps, Robert Maynard Hutchins, Otis Skinner, John Grier Hibben, Irving Fisher, Charles Evans Hughes. Here as in other cases it is not possible to determine the relative importance of heredity and environment.

We have the story of the family of the illustrious Jonathan Edwards which shows innumerable examples of the highest intellectual and moral worth among its descendants. On the other hand we have the story of the Jukes family investigated by Dugdale and concerning which we find the following statistics. In five generations of the descendants of a worthless fisherman there were 1200 persons, including 200 who married into the family; the history of 1040 of these people is partly known or well known. About 300 died in infancy, of those remaining 7 were murderers, 60 were habitual thieves, 130 were convicted criminals, 140 were physically wrecked by their own diseases and wickedness, more than half of the women were prostitutes, and 310 were professional paupers living in almshouses a total of 2300 years, not one of these people had a common school education and only 20 learned a trade, 10 of whom learned it in a state prison. Here of course it is not easy to separate heredity and environment.

Perhaps a somewhat more striking example of the importance of heredity is to be found in the story of the "Kallikak" family which has been cited by Dr. Henry Goddard (*The Kallikak Family, a Study in Heredity and Feeble-mindedness*). Here is the story of a revolutionary soldier who had a son by a feeble-minded girl. The boy was feeble-minded and from him there descended a long line of degenerates, similar to those we have just described among the Jukes family. After the war, Kallikak, who was of good English descent, married a Quaker girl of good ancestry and from this legitimate union a long line of descendants has been traced, all of whom held positions in the upper walks of life and none of whom were criminals or ne'er-do-wells.

Feeble-mindedness.—The normal individual must accept his responsibility for race betterment in deciding the question of marriage, but the problem involved in preventing the propagation of the mentally deficient is one which society must handle. These feeble-minded people are divided into three groups according to mentality. The *idiot* has a mental age no greater than that of a normal child of two years, among *imbeciles* the mental age remains at about that of the four year period, while the *moron* has a mental age not greater than that of a twelve year old child.

None of the four measures, which have been proposed for controlling the propagation of defectives is fully satisfactory. These measures are (1) education, (2) legislation, (3) segregation, and (4) surgery. *Education* of the general public may make society more alert to this problem for it is certainly startling when we realize that America has about half a million insane, feeble-minded, epileptic, blind and deaf; 80,000 prisoners, and 100,000 paupers, who are supported at a cost well over a hundred million dollars a year. *Laws* limiting the marriage of feeble-minded people have been enacted in many states. *Segregation* is an ideal procedure where it can be applied but it is hopeless to attempt to secure all the afflicted and to place them in segregation hospitals. Resorting to

surgery, the simple operation of severing the vas deferens or the slightly more complicated operation of severing the Fallopian tube, has been practiced but there is a serious danger from the misuse of this surgical measure and a practical difficulty in determining where it shall be applied.

Heredity and Conduct.—A somewhat different phase of the Hygiene of Reproduction concerns a question which is naturally and often asked, namely, what effect will one's habits, virtues, and vices have upon the offspring. The present theory regarding the inheritance of acquired characteristics is indicated in the surgical experiment of Dr. W. E. Castle in which the ovaries from a small black guinea pig were transplanted into an albino (pure white) guinea pig, which was later mated with another albino. The offspring produced were black. This experiment shows that the hereditary qualities lay in the germ cells and not the body as a whole.

We know also that embryologically the sex cells are early separated from the rest of the body and that the ova themselves are already formed in full number at the time of birth. Mutilation experiments, like cutting off the tails of mice for several generations, have failed to show any shortening effect in inherited character.

One may say that, from the standpoint of the race, the germ cell is of greater importance than the individual. This in general is true, for a person is like the father merely because he is decended from the same line of similar germ cells. The children of soldiers mutilated in war will be normal in every respect so far as the influence of these mutilations is concerned. An injury to the germ cells is much more serious than an injury to the body tissues of the individual.

The number of cells of the body which, through one's descendants, may outlive the span of his own life is determined by the number of his children. We cannot change the hereditary characteristics which are embodied in these cells, but we should remember that these cells are a living part of

the body and that they are subject to some of the same influences which injure other tissues. We would expect to find the greatest vitality in those cells which are in a normal and healthy body.

Certain poisons, which are distributed through the circulation, can reach these cells and a poison which is capable of serious injury to the growing or adult organism may thus be expected to reach in its baleful influences to the unfertilized sex cell. Lead is such a poison. When it gradually accumulates in the system it not only injures the body of the parent but it injures the germ cells as well. When there is serious lead poisoning in either the father or the mother the number of still-born children is greatly increased and those who do live are often of inferior vitality.

The poison from syphilis is a substance which has most harmful effects, especially upon the nervous system of children. This disease, moreover, as we shall see later, may be inherited in the active and contagious form. Gonorrhea is not inherited but there is danger of infection of the child at birth and the deleterious effects upon the sex organs of the parent may be serious. The case against alcohol is not as clear for the evidence of physical or mental inferiority in the children of alcoholics is conflicting. Possibly none of these substances are true race poisons, as the offspring which *do* survive do not appear to pass on the defects to the next generation. But certainly a belief in the noninheritance of acquired characteristics is not an argument for intemperance and incontinence.

One may ask, however, whether this does not end the parental obligation to exercise proper control over the temper and the nervous system generally. The answer would be that faulty hygiene in these respects will injuriously affect the general vitality of the individual and, what is more important, the environment of the children. If the individual is a confirmed neurasthenic, he should make certain that he does not injure his children's mental health.

PRENATAL CARE

It is not enough that a child should have a good inheritance; if it is to be well born it must live under proper conditions during the fetal period and if it is to start life without physical handicaps it must be given special and proper care during its early infancy and childhood. The great need is that mothers should realize that childbirth is an exceedingly important affair which involves the future health of two individuals. The expectant mother should early realize her condition and seek the advice of the best physician available.* In many centers of population the health departments carry out a proper function in providing health centers where advice upon these subjects can be secured.

We may enumerate some of the reasons why it is important for the prospective mother to consult her physician or one of the health centers when, by the absence of menstruation or other signs of pregnancy, she realizes her condition. She should know that the heavy tax upon the system and the extreme muscular energy required at childbirth make it in reality "an athletic event" and she must begin training for this, the most important event in her life. While pregnancy is a physiologic process there is probably no condition in life which may so quickly become pathologic. She should have a thorough physical examination to see whether there are any organic defects. This should include an examination of the heart, the lungs, urine, and blood.

The teeth should be given careful examination because their decay during pregnancy is extremely rapid. For this decay two probable causes have been suggested: the failure of the woman to drink enough milk and eat enough greens, fresh fruit, and vegetables to supply the required amount of lime salts for her own metabolism and for the development of the bones and teeth of the growing child; and the prob-

*Literature on prenatal hygiene can be secured from any State Department of Health or from the U. S. Children's Bureau.

able increase in the acidity of the mouth. Repair work should put the teeth in perfect condition early in pregnancy and they should be given daily attention.

If it is the first pregnancy, the physician who is to take care of the case will also measure the pelvis to see whether there is danger of obstruction to labor because of the small size or abnormal shape of the pelvic canal. He will also be on the watch for albuminuria and eclampsia, and will require the patient to submit a sample of urine at least once a month. The latter condition, a common cause of convulsions, may be largely avoided, even among women bearing the first child, by early detection and proper hygiene. Patent medicines advertised to make childbirth safe, easy, and painless are frauds, and cannot be substituted for the services of a physician.

The wise woman will avoid sluggish skin, bowels, and kidneys. Especially will she limit her protein food, stressing instead water, milk, and whole cereals, fruits, green vegetables, and such laxative diet as will insure thorough excretion of waste products. Following is a list of directions prepared by an obstetrician for the use of his patients.

DIRECTIONS DURING PREGNANCY

Be careful to bring or send a clean specimen of the urine every week. Have your name and address on the bottle. Even if feeling perfectly well, come to the office at least once a month.

If possible, drink each day six glasses of water between meals—one the first thing in the morning—two during the forenoon; two during the afternoon; and one just before retiring.

Be careful to have the bowels move regularly each day; and report any inability in this direction.

Keep the skin healthy by frequent bathing. Shower baths are better than tub baths during the last three weeks.

For exercise, the average woman may safely pursue her usual household duties, though she also needs an hour daily in the open. Avoid lawn-tennis, horseback riding, and fast or rough motoring.

Bathe the nipples night and morning with the solution prescribed.

Wear loose clothing, capable of being adjusted to the increasing size

of the abdomen. There is no objection to loose fitting corsets. Do not wear circular garters or tight brassieres.

Report headache, vomiting (especially after the middle of pregnancy); any marked swelling of limbs or face; any disturbance of vision; any bleeding or escape of water; any pain with regular recurrences.

Standards for Maternity Care.—Since the beginning of time maternity has been of such casual occurrence that we have scarcely realized at what cost our children came into the world. Statistics of the United States Census Bureau (1926) indicate that over 15,000 women lose their lives annually from childbearing. This represents one of the highest death rates between the ages of fifteen and forty-five. As a result of constant research and scientific endeavor the death rate from tuberculosis and other perilous diseases has steadily declined, while the death rate from childbirth shows no comparable reduction.

The accompanying table shows how our own and certain other countries are protecting their mothers from the hazards of maternity.

DEATHS OF MOTHERS FROM CAUSES CONNECTED WITH CHILDBIRTH PER 10,000 LIVE BIRTHS (UNITED STATES CHILDREN'S BUREAU)

	1923	1925	1927
Denmark	26	24	31
England-Wales	38	41	41
Germany	52	53	—
Japan	34	30	28
Netherlands	23	26	29
New Zealand	51	47	49
Switzerland	46	43	37
Uruguay	27	25	22
United States	67	65	65

The entire responsibility for this high mortality need not be borne by the medical profession. So long as women wait for the onset of labor before placing themselves in the care of a physician they must accept their share of responsibility for the disasters attending their own welfare and the welfare of their babies. There is a growing and justifiable un-

willingness on the part of doctors to accept a confinement case unless the woman's pregnancy has been supervised by a private physician or by a health center.

In certain foreign lands well-trained and supervised midwives are supplied to women of limited means, and the maternal mortality of those countries compares favorably with the mortality of the United States. Thousands of babies are delivered by midwives in this country every year and for some time health authorities have been carrying on an important and beneficial campaign to raise the requirements for the practice of midwifery. Another potential force in reducing maternal mortality is an increased number of rural hospitals.

The responsibility of the community or the state in providing the proper facilities for suitable maternity care is set forth in the following list of requirements prepared by the Children's Bureau of the U. S. Department of Labor as part of a set of minimum standards for child welfare.

1. Maternity or prenatal centers, sufficient to provide for all cases not receiving prenatal supervision from private physicians. The work of such a center should include:

(a) Complete physical examination by physician as early in pregnancy as possible, including pelvic measurements, examination of heart, lungs, abdomen, and urine, and the taking of blood pressure; internal examination before seventh month in primipara; examination of urine every four weeks during early months, at least every two weeks after six months, and more frequently if indicated; Wassermann test whenever possible, especially when indicated by symptoms.

(b) Instruction in hygiene of maternity and supervision throughout pregnancy, through at least monthly visits to maternity centers until end of sixth month, and every two weeks thereafter. Literature to be given mother to acquaint her with the principles of infant hygiene.

(c) Employment of sufficient number of public-health nurses to do home visiting and to give instruction to expectant mothers in hygiene of pregnancy and early infancy; to make visits and to care for patient in puerperium; and to see that every infant is referred to a children's health center.

(d) Confinement at home by a physician or a properly trained and qualified attendant, or in a hospital.

(e) Nursing service at home at the time of confinement and during the lying-in period, or hospital care.

(f) Daily visits for five days, and at least two other visits during second week by physician or nurse from maternity center.

(g) At least ten days' rest in bed after a normal delivery, with sufficient household service for four to six weeks to allow mother to recuperate.

(h) Examination by physician six weeks after delivery before discharging patient.

(Where these centers have not yet been established, or where their immediate establishment is impracticable, as many as possible of these provisions here enumerated should be carried out by the community nurse, under the direction of the health officer or local physician.)

2. Clinics, such as dental clinics and venereal clinics, for needed treatment during pregnancy.

3. Maternity hospitals, or maternity wards in general hospitals, sufficient to provide care in all complicated cases and for all women wishing hospital care; free or part-payment obstetrical care to be provided in every necessitous case at home or in a hospital.

4. All midwives to be required by law to show adequate training, and to be licensed and supervised.

5. Adequate income to allow the mother to remain in the home through the nursing period.

6. Education of general public as to problems presented by maternal and infant mortality and their solution.

INFANT CARE

The birth and the early days of infant life should represent the important culmination of all these weeks of care and it goes without saying that the best obstetrical services should be secured and that the mother should be given an opportunity to rest after this ordeal. During the prenatal period and the early days of infancy the district or public health nurse is the mother's invaluable aid, and her activities under a properly managed health department have always shown a saving of mother and infant lives.

It is exceedingly important that the mother should learn from her physician, from the health center or from literature

on infant hygiene, the essentials in caring for her baby. She should keep in mind the following advantages of breast feeding:

1. Four bottle-fed babies die to every breast-fed baby (95 per cent of mothers can nurse their babies).
2. Breast milk is always available.
3. It is always clean, is of the right temperature, and of proper chemical constituency.
4. Nature adapts it to the needs of the growing baby.
5. It affords protection from infectious diseases.

She should eat only foods which agree with her or otherwise the quality of her milk may change; and if possible she should avoid weaning the baby in the hottest weather when intestinal diseases among children are most common. The baby's clothing should not be too warm or too tight. Baby needs fresh air and rest and not continual movement by being tossed in the air. The house must be kept clean. The daily bath should be properly administered; during the first three months the water should be about body temperature.

All these and many other things are highly important to the welfare of the infant and are mentioned here only to reinforce the statement that the importance of childbirth demands that the mother should properly inform herself through the aid of her physician or the organized health department of her state or city.

The following quotation from a pamphlet on *Breast Feeding Her Baby* in the "Keep Well Series" of pamphlets issued by the U. S. Public Health Service, is an example of the excellent, concise and specific health literature available from government agencies.

Of every 100 bottle-fed babies 25 die in the first year of life; of every 100 breast-fed babies only 6 die in the first year of life.

Nearly every mother can nurse her baby during the first three or four months of its life, and if she can nurse it for ten months so much the better.

There may be an abundant supply of milk after the first few weeks, even if there is but little at first; the act of nursing causes the milk

to come into the breasts and increases the supply. It is very important that the baby nurse regularly.

In case the baby is not getting enough milk, the quantity lacking should be made up by properly prepared, safe cow's milk. Let a physician decide this. There may be only a temporary shortage on the mother's part, and with suitable care the milk will probably increase so that the breast supply will eventually become sufficient.

Peace of mind is necessary for the nursing mother; she should have no worries; she should not get overtired. She should eat freely of her customary diet. The total quantity of fluids taken by her in 24 hours should not be less than 2 quarts; more in hot weather. Stuffing, however, is unnecessary and undesirable.

Tuberculosis in the mother is practically the only disease that always forbids nursing. Paleness, nervousness, fatigue, pains in the back and chest, or the return of the monthly sickness are not sufficient reasons for weaning, but when these symptoms are present or pregnancy ensues a physician should be consulted at once.

Shortly after birth, boiled water, without sugar, may be given to the baby at regular intervals until the mother's milk supply is established. The baby, however, should be put to the breast at stated times, as often as the mother's condition permits.

It is always wise to make nursing as easy as possible for the mother and to give her opportunities for rest. Therefore, the sooner the baby is satisfied and gaining on three-hour or even four-hour intervals the better.

Convenient hours for nursing the baby are as follows:

1. Seven nursings in 24 hours.—6 a. m., 12 noon, 3 p. m., 6 p. m., 8 or 10 p. m., and once during the night.

2. Six nursings in 24 hours.—6 a. m., 9 a. m., 12 noon, 3 p. m., 6 p. m., and at the mother's bedtime; or at 6 a. m., 10 a. m., 2 p. m., 6 p. m., 10 p. m., and one during the night.

3. Five nursings in 24 hours.—6 a. m., 10 a. m., 2 p. m., 6 p. m., 10 p. m., or later.

The baby should be offered cooled boiled water between feedings, especially during hot weather.

The length of time for a nursing varies with the infant and with the breast. The average infant rarely nurses longer than fifteen minutes. The important point is to satisfy the baby. If there is any doubt, let it nurse longer, but not more than twenty minutes. If it is not satisfied after twenty minutes, consult a physician.

It is customary to nurse only with one breast at each feeding, and to use them alternately. If, however, the baby does not get enough from one breast, give it both.

It is important to keep the nipples clean; they should be washed before each nursing. Caked breast, or cracked nipples, although they may be harmful to the mother, do not make the milk poisonous for the baby. In both instances consult a physician, for a breast abscess may result if the condition is not attended to. The baby should usually be completely weaned at the end of the first year. Up to this time breast milk should be given to the baby as long as it thrives. It is better, when possible, to continue nursing through the summer and to wean in the fall, but if the year has not been completed in the spring, it is better to wean in the summer than in the spring.

Do not wean the baby suddenly; it should be done gradually by replacing one breast feeding at a time with a bottle feeding. Several weeks are required for weaning.

It is dangerous to wean a young baby. It should not be done for the convenience of the mother and should never be done without the advice of a physician.

When the mother's milk is diminishing it is advisable to make up the lack with properly modified cow's milk. This may be done either by following one or more breast feedings with enough modified milk to satisfy the baby or by giving one or more full bottle feedings in place of a like number of breast feedings.

The flow of breast milk tends to diminish when the baby nurses less than five times in 24 hours. When the baby is being nursed once every four hours and is not satisfied it is better to replace a nursing with the bottle. If, however, shorter intervals and more feedings are being used, a bottle feeding may take the place of a nursing without so much danger of decreasing the supply of breast milk. Most babies need additional food after the seventh month.

The Infant and the Preschool Child.—England showed us what it is possible to do by actually reducing the infant mortality rate to the lowest point in her history while the World War was being carried on. This was accomplished providing for the compulsory notification of births within thirty-six hours, government aid for local maternity and infant welfare work amounting to not more than 50 per cent of the approved expenditure, publicity explaining the government plan with its details for antenatal, natal, and postnatal work, and a great increase in the number of health visitors.

The accompanying table shows what progress is being made in various countries. Our own infant mortality still leaves much to be desired as compared with that of New Zealand, Norway, and Switzerland.

DEATHS OF INFANTS UNDER ONE YEAR OF AGE PER 1,000 LIVE BIRTHS

	1922	1924	1927
Denmark	85	84	83
England-Wales	77	75	70
Germany	130	109	—
New Zealand	42	40	39
Norway	55	50	51
Switzerland	70	62	57
United States	76	71	65

The duty of our own communities is set forth by the Children's Bureau in the following set of standards for Child Welfare relating to infants and preschool children.

1. Complete birth registration by adequate legislation requiring reporting within three days after birth.

2. Prevention of infantile blindness by making and enforcing adequate laws for treatment of eyes of every infant at birth and supervision of all positive cases.

3. Sufficient number of children's health centers to give health instruction under medical supervision for all infants and children not under the care of a private physician, and to give instruction in breast feeding and in care and feeding of children to mothers, at least once a month throughout the first year, and at regular intervals throughout preschool age. This center to include a nutrition and dental clinic.

4. Children's health center to provide or to cooperate with sufficient number of public-health nurses to make home visits to all infants and children of preschool age needing care—one public-health nurse for average general population of 2,000. Visits to the home are for the purpose of instructing the mother in—

(a) Value of breast feeding.

(b) Technic of nursing.

(c) Technic of bath, sleep, clothing, ventilation, and general care of the baby, with demonstrations.

(d) Preparation and technic of artificial feeding.

(e) Dietary essentials and selection of food for the infant and for older children.

(f) Prevention of disease in children.

5. Dental clinics; eye, ear, nose, and throat clinics; venereal and other clinics for the treatment of defects and disease.

6. Children's hospitals, or beds in general hospitals, or provision for medical and nursing care at home, sufficient to care for all sick infants and young children.

7. State licensing and supervision of child-caring institutions or homes in which infants or young children are cared for.

8. General educational work in prevention of communicable disease and in hygiene and feeding of infants and young children.

It will be interesting for the student to investigate the extent to which these standards are met by his own community.

SEX HYGIENE

A properly arranged sex life cannot be insured by preaching fear and the consequences of immorality, but certainly the proper basis for a normal sex life in the developing child is adequate knowledge. The old-style false modesty and innocence has been shown in many cases to be not only useless but dangerous and pernicious. And yet in turning from the Scylla of ignorance let us not run into the Charybdis of vulgarity by providing the child with information in such a material and commonplace manner that the abandonment of all modesty and restraint in social conduct will be the inevitable result.

Sex Education.—Instruction in sex hygiene may be divided into three parts. Beginning at the age of three years the child is likely to ask questions as to whence it came. It should be given a truthful answer to its questions but no more. Old stories about the stork are not to be used, but on the other hand, this is not the time and place to teach sex hygiene and prophylaxis. This inquisitiveness dies out to a large extent at about the age of five. By this time the child should learn that questions concerning these subjects are to be brought to the parent.

The second stage of instruction is just before the age of puberty—twelfth to fourteenth years. At this time the child should be given certain information about the changes which it is soon to undergo. The instruction should be brief, per-

sonal, and individual. This is a task for the parent, doctor, or friend, but not for the public school. The story is brief and can be told in a few minutes. It should not fire the imagination but should warn against abuse and explain how it is that continence is entirely compatible with health. Such instruction wins the friendship and confidence of the child.

The third stage of instruction is to be given to young men and women at the age of sixteen to eighteen years, and concerns chiefly information regarding the venereal peril. Suitable books may be found on the shelves of any good library and may well be used to precede such a talk. Here again high school biology is not the place for the subject to be taught.

Fear alone is not a deterrent, but an actual knowledge of the dangers in the path and a true picture of the beauty of virtue, appealing to the boy's love for sister and mother with a consideration of the obligations to the future wife, will go far to pave the way for proper living. We may deplore the double standard of morals, but in changing it, we must see that the boy accepts the standard of the girl and that we preach equal restraint, not equal liberty, for belief in the chastity of women is a most important restraining influence in the boy and young man. It is hardly necessary to add that a vigorous physical life, helpful social surroundings and abstinence from alcohol are most important factors.

Summary.—In *The Child's Ten Commandments to Parents,* written some time ago for the *American Journal of Public Health,* the writer has summarized many of the obligations mentioned above:

The Child's Ten Commandments To Parents

And a new voice said to the people,

I am the generation yet unborn who by being well born and properly cared for shall lead the race out of the bondage of disease to a healthier, better, and happier life.

Thou shalt have no temporal gods before me.

Thou shalt not bow down thyself before false images of temporal pleasures or become bound by overwork or by intemperance in thy food, thy drink, or thy habits, for thy God is a righteous God and visiteth these sins in the form of physical weakness upon thy children.

Thou shalt not take my name in vain or think lightly of me in thy younger days for thou must begin when a boy or girl to prepare for my coming, by building a strong body and keeping it free from harmful substances and the taint of disease.

Remember the pre-natal days and keep them properly. Other days shalt thou do hard labor if need be, but these are the months that are mine, and thou shalt seek advice of thy physician and so conduct thy life and that of thy family that I may become strong and not afflicted in these days of my coming.

Honor thy sons and thy daughters that our days may be long upon the earth; when we are babes give us the food which nature intended us to have and see that such hygienic measures prevail in thy house and in the community where thou livest that we shall not be menaced by disease.

Thou shalt not kill our confidence in thee by telling us lies about ourselves, and when at an early age we begin to ask from whence we came, thou shalt answer the questions truthfully and volunteer no further information.

Thou shalt not make it easy for us to commit sexual excesses by neglecting to tell us at the time of puberty what changes are to come upon our physical beings, and at the time of early manhood or womanhood thou or thy trusted friend shall explain to us individually the nature of those diseases which may inflict suffering upon us and upon those we love, explaining also the rules of personal hygiene, which will enable us to avoid all excesses that would make us in our generation unfit for parenthood.

Thou shalt not steal our peace of mind by failing to inform thyself and consult with us frankly upon problems involving the proper development of the body, the mind, or the social and religious conscience.

Thou shalt not bear false witness to what thou wouldst have us believe by leading a life which is unhygienic, empty of serious thought or immoral.

Thou shalt not covet ease for thyself or thy children thereby forgetting the duties of every person as a citizen and a neighbor.

CHAPTER VII

HEALTH MAINTENANCE

If one is to maintain his body in a state of health, he must have not only a hygienic program of living but also accurate information concerning health hazards of adult life. Some of these, such as communicable diseases and conditions arising from industrial or other external risks, may be problems of community concern. Others, however, are largely matters of personal responsibility.

During the past generation great progress has marked the efforts of research workers in the prevention and control of certain hitherto disastrous diseases. By combined efforts of federal, state, and municipal agencies such seemingly indomitable infections as yellow fever, typhoid fever, and malaria are fading from the picture of American life. During the Civil War, typhoid fever (with typho-malaria) caused 22.4 per cent of the deaths; in the fighting period of the Spanish-American War, 60.5 per cent of all deaths; while in the World War this disease caused but 0.4 per cent of the total deaths. The death rate from dread diphtheria has been greatly reduced and conditions hitherto responsible for such an infant mortality as brought reproach upon our nation are yielding to sustained scientific effort. Even tuberculosis has been pushed from first place to fourth place among the causes of death. Similar reduction has not been made in the diseases of adult life. While stressing certain infections and ills peculiar to the early age period, we have allowed those of mature years to steal upon us.

Disabling, life-sapping diseases are demanding their toll. The wise man who would prolong and enrich his life to its full extent will seek to avoid these diseases by such means as are available. The leading causes of death today are heart disease with an annual death rate of 195.7 per 100,000

population; cancer with a rate of 95.6; acute and chronic nephritis with a rate of 92.5 (Bureau of Vital Statistics, United States Department of Commerce, 1927).

Early detection of these conditions is of prime importance and the annual physical examination provides the means. The wise man goes, not occasionally, but periodically to be checked up by one more skilled than himself in detecting early signs of trouble. He goes to his own doctor, to his life insurance physician, or to the nearest representative of the Life Extension Institute. If in industry, he may receive adequate physical supervision there, and in some cities today he will find skilled service of experts at pay clinics for men of moderate means.

Heart Disease.—As the commonest cause of death today, heart disease deserves careful consideration. Undoubtedly much of this mortality can be prevented by intelligent use of the various means at our disposal.

The common types of heart disease are endocarditis (inflammation of the heart lining or endocardium), and myocarditis (inflammation of the heart muscle). These may be caused (1) by such acute infections as rheumatic fever, tonsillitis, or scarlet fever, (2) by such chronic infections as syphilis or chronic focal infection of the tonsils, sinuses, or roots of teeth, (3) by the excessive use of such intoxicants as alcohol or tobacco, and (4) by prolonged wear and tear.

It is not always possible to prevent the microorganisms of an acute local infection from being swept by the blood stream to the heart. This may start an inflammation of the endocardium, of the valves, or even of the myocardium itself. In the case of chronic infections, however, annual examinations will usually help to prevent or control the development of the exciting cause.

Neglected infection of heart lining or heart muscle leads inevitably to the formation of scars but with prompt medical care compensation may be established and the patient

gets on very well with a program of restricted activities. Chronic infection of the heart associated with the excessive use of alcohol or tobacco are, of course, wholly within the control of the individual.

The heart that fails because of undue strain or prolonged wear and tear may be found in the zealous athlete, in the middle-aged man who attempts too suddenly or violently to renew his youth; in a man resuming hard physical labor after a prolonged illness, or in the neurotic individual who

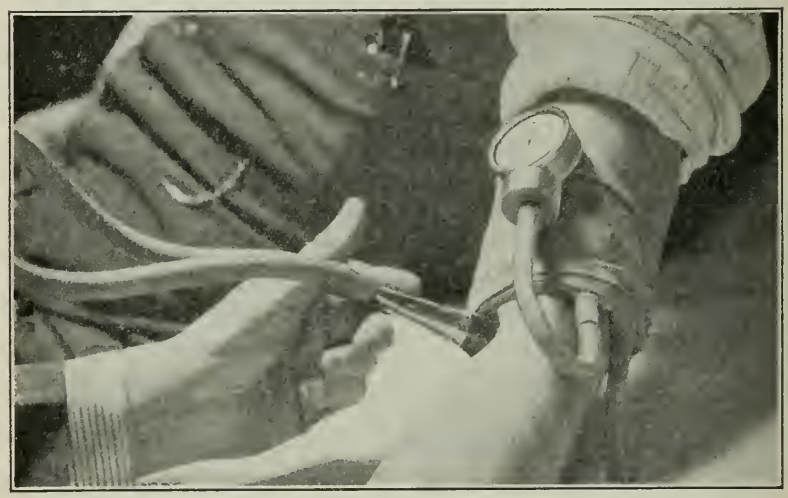


Fig. 28.—Taking the blood pressure with a Rogers "Tycos" dial sphygmomanometer. (Courtesy Taylor Instrument Companies.)

may, by his own groundless fear and anxiety, induce a hypersensitive heart with exaggerated response to trifling stimuli.

Diseases of the Blood Vessels.—The public is familiar with the terms high blood pressure or hypertension and arteriosclerosis or hardening of the arteries. Hypertension means a constant constriction of the blood vessel walls. These in time show an increased amount of fibrous tissue and of calcareous deposit, becoming what is called arterio-

sclerotic. A sudden, unexpected mental or physical shock may throw undue strain upon these stiffened, inelastic vessel walls. A ruptured blood vessel wall in the brain may mean a cerebral hemorrhage with apoplexy and possible paralysis. Although arteriosclerosis may occur quite independently of other diseases and be of unfathomable origin, it is nevertheless often associated with heart and kidney lesions. The cause of impaired arteries and veins is, like that of an impaired heart, largely within the control of the individual—prevention of infectious diseases, avoiding intoxicants, keeping the body fit. The reassurance and recommendations received by an annual examination will then go far toward protecting one from these untoward eventualities.

Cancer.—Next in point of gravity as a cause of mortality we find cancer and other malignant growths. During our two-years' participation in the world war more than twice as many deaths from cancer occurred at home among the civilian population as from active service among our men at the front. The incidence of cancer is steadily increasing.

Cancer appears when, for unknown reasons, a group of cells develops into an abnormal growth, often migrating to other parts of the body. It is likely that the original cause may be harbored in the body from early youth, but its development is delayed until after forty. Cancer is most common in women, especially attacking the breast or genital organs of one subjected to frequent childbearing. Smoker's cancer of the tongue or lip is not rare, however, in men, and prolonged irritation from other causes may induce similar growths.

Dr. Maude Slye, after careful research with mice, insists that cancer acts as a recessive unit character. According to her "The first hybrid generation (result of mating an animal of cancerous strain with an animal of noncancerous strain) shows no cancer. It reappears, however, in the sec-

ond hybrid generation and in the same organ as in the cancerous stock from which the original grandparent sprang."

Warthin and Levine have convinced themselves after intensive study of cancer that the facts accumulated by Slye in mice are substantially true for man. There is still difference of opinion, however, as to whether Dr. Slye is justified in her contention that there is a possible, though considerably involved "genetic method of escape from cancer."

As late as 1925 Gye and Barnard claimed that undoubtedly a certain form of cancer may be transmitted from a diseased animal to a well one by the use of a certain "virus" obtained from tumor extracts. They agree that in addition to the virus there must be either chronic irritation or a second specific factor obtained from tumor extracts, which ruptures the cell defences and permits the virus to act.

The theory is advanced also that certain nutritional disturbances play a part in the development of cancer. One suggests a lack of vitamin A; and another authority believes that cancer is one of the many unfavorable results of the highly refined diet of our more civilized day. On general principles a return to simpler, coarser food would not be amiss.

The conclusion of earnest but varied research leaves us still at sea as to a specific cause of cancer, its cure, and especially its prevention. The theories of its causation suggest certain lines of action. Our daily observation of the course of this malady are convincing evidence of the fallacy of temporizing with any focus of irritation due to mechanical, thermal, chemical, or actinic cause or with any sore, ulcer, burn, or mass appearing on any part of the body and refusing to yield to simple remedies. Even more hazardous is the resort to quackery with its alluring promise of miraculous cure—and the consequent loss of valuable time. The most scientific physician or surgeon can offer no cure for neglected cancer. He is, however, the "key man of cancer control."

Upon him rests the burden of early diagnosis and complete removal of the original offending growth by means of surgery or the x-ray. Here, again, an annual physical examination gives one the surest protection.

Nephritis (Bright's Disease).—The function of the kidneys is to remove from the blood daily from three to four pints of water containing certain waste products from protein foods. Anything interfering with the excretion of this waste material may set up an inflammation commonly known as Bright's disease. Acute nephritis in childhood may follow scarlet fever or other infectious disease. In the adult it may result from undue strain or exposure. It usually yields to rest, proper medical care, and the avoidance of protein foods, tobacco, alcohol, or other stimulants.

Chronic nephritis, however, is another matter. This occurs in older people, especially those indulging in an inactive life, in too much food, or the accumulation of more protein waste than sluggish kidneys can eliminate.

Premonitory signs may often be detected by a physician before the patient is aware of trouble. It is important, therefore, when the annual physical examination is made to include urinalysis for the detection of albumin, casts, or other suspicious substances in the urine.

Diabetes.—This disease results from an insufficient secretion of insulin by the cells of the pancreas. This secreted substance is picked up by the blood and enables the body to use or "burn" sugar. In its absence the body cannot handle carbohydrates. In children the disease usually assumes an acute form, and without treatment is almost invariably fatal. Chronic diabetes, on the other hand, attacks the middle-aged, especially in the presence of localized infections, such as pyorrhea, appendicitis and the like. It is usually associated with a sedentary life and overeating, especially an excess of sweets. This may often be revealed when a physical examination shows sugar in the urine. The disease usually attacks fat people and is evidenced by short-

ness of breath, marked weakness and exhaustion, and intense thirst. The treatment consists largely in regulating the diet, and supplying to the body regularly a sufficient amount of insulin to dispose of the excess of sugar stored.

Endocrine Disorders.—The salivary glands throw off their secretions through a duct; the pancreas and testes throw off theirs partly through a duct and partly into the blood stream. The endocrine glands throw their secretions or hormones into the blood stream directly and entirely. This system of glands consists of the thyroid, the parathyroid, thymus, the adrenals, the pituitary, and pineal glands. The hormone of each gland plays its own part in supplementing the action of other glands and tissues.

Endocrinology is one of the newest and one of the most promising fields of study. It is often difficult to isolate the endocrine substance and equally difficult to remove the gland in experimental animals and obtain clear-cut observations of the effect. This is not the place for an extended discussion of the physiology of each of these glands and their products. We desire to present, however, a discussion of the endocrine disorders which are of greatest importance from the standpoint of practical hygiene, namely, those associated with the thyroid gland.

The thyroid gland consists of two lobes two to three inches in length connected by an isthmus and located in front of the larynx. It produces thyroxin as the active principle of the thyroid hormone or secretion. A young animal deprived of its thyroid shows delayed ossification of bones. The long bones fail to attain their normal length and the animal is malnourished. These conditions may be remedied by feeding thyroxin or thyroid tissue or by grafting thyroid tissue into the body.

In man, when thyroid tissue is absent from birth, cretinism (feeble-mindedness and retarded growth) results. An adult deprived of its thyroid gland shows greatly diminished oxidation, and finally marked malnutrition. This con-

dition may respond promptly to the administration of thyroid extract. Atrophy or removal of the gland results in mental deterioration, thickening and drying of the skin, and diminished oxidation. Overactivity of the gland (hyperthyroidism) is marked by increased oxidation, excessive nervousness, a rapid heart, and characteristic bulging of the eyes. Relief may be given by removing enough of the gland to restore endocrine balance.

The most common endocrine disorder associated with the thyroid gland is simple goiter. This is an enlargement of the gland which usually occurs at adolescence and appears to be due to a deficiency of iodine in the system during this period of rapid growth. It is rarely found on the seashore or in sections of the country where the soil, and consequently the crops, possess a protective amount of iodine. In sections of the country where, as in some of the Northern states, the amount of iodine in the soil and water is negligible, simple goiter has been very common. The prevention of this condition seems to lie in restoring a suitable amount of iodine to the diet. Perhaps the simplest and most approved method of accomplishing this end is through the use of iodized salt. Some agricultural districts are considering the feasibility of iodizing the garden soil. Many sea foods, like salmon and sea moss, contain iodine in appreciable quantity.

Many young people seem to adapt themselves after adolescence to this shortage of iodine, and the only continuing effect of simple goiter is the disfiguring enlargement of the thyroid gland. On the other hand, some people fail to make this adjustment and are confronted with two more serious dangers, the one that the simple goiter may develop into hyperthyroidism, or toxic goiter, and the other that their children, born of goitrous parents, may be injuriously affected with reference to their mental and physical development.

It can be seen at once that the existence of hyperthyroidism, which is made worse by taking in an excess of iodine, presents a problem with reference to any of the previously mentioned methods of administering iodine to the population at large. Active cases of hyperthyroidism should be under medical care, however, and recent experience indicates very satisfactory results with the general administration of the minimum necessary dosage of iodine in the form of iodized salt.

Hay Fever.—Another malady which the individual may need to guard against is hay fever. This is a distressing and often a disabling disease coinciding with the pollination of certain plants. It is due to irritation caused by a protein element of the pollen of trees, grasses, weeds, or even roses. The symptoms are itching, burning, weeping, and sneezing. The patient complains of congestion of the nose, of constant secretion from mucous membranes, and often suffers with asthmatic breathing. Hay fever is likely to be augmented when wind carries the pollen hither and yon, and is often relieved when rain washes the air free of its disturbing presence. A wet cloth kept over the patient's window serves as a sieve to keep out the offending irritant. One must avoid railroad or automobile trips over dusty roads. Dust alone may excite a recurrent attack of hay fever.

The first step in prevention or cure is to discover the particular sensitizing pollen. This is done by placing dilute solutions of different pollens upon a series of shallow scratches made in the skin of the forearm. The pollens to which the person is sensitive produce transient swellings which look somewhat like mosquito bites. Others produce no reaction. Having discovered the plant which is the cause of the trouble, the individual may be able to keep away from its pollen. If not, it is worth while for him to seek treatment by having a series of inoculations with the pollen in question beginning a couple of months before its season. These treatments may need to be repeated for a

few years and the degree of improvement varies with different individuals, but definite benefits are usually obtained.

Asthma is a word associated with hay fever in the public mind. This is a general term loosely applied to difficult

Fig. 29.—Diagnostic skin tests for hay fever, showing a positive reaction to June Grass and Timothy Pollen Allergen solutions. (Courtesy of E. R. Squibb & Sons.)

breathing. It is a condition arising from inhalation, ingestion, or absorption of some of the proteins of pollens, foods, epidermis (including dried skin, dandruff, hair, feathers), or bacteria. Like hay fever it is a protein reaction and subject to the same principles of prevention and treatment.

PART II
COMMUNITY HEALTH

CHAPTER VIII

THE SCIENCE OF DISEASE PREVENTION

Thus far we have considered mainly the normal functioning of the body in the endeavor to point the way toward the normal conduct of life and the avoidance of diseases which arise from some derangement of the body mechanism from within. There is another group of diseases, those which arise from without the body. We are now to turn our attention to them. Such diseases are comparable to the troubles with a machine arising from the entrance of foreign bodies. By the recent and rapid development of preventive medicine, sanitation, and hygiene the number of deaths from this group of diseases is being rapidly reduced, and it is here that the greatest opportunity for prevention lies. In the body, as in the machine, it is possible to prevent these injuries arising from without while the results of wear and tear will eventually make themselves felt. We shall consider the development of our knowledge of communicable diseases and the organization of governmental and social agencies to combat them.

Early Theories of Disease.—It is difficult to realize that our knowledge of the cause of communicable disease does not date back of our own Civil War and that many people now living can distinctly remember the days when germs were unknown. Previous to this time the world had entertained vague notions as to the nature of these maladies, including the early conceptions of primitive man, the doctrines of Hippocrates and later the doctrines of Sydenham.

The tendency of primitive man to personify all natural phenomena led to the earliest conception of disease as the

activity of individual demons and according to this *demonic theory* pain, disease, and death were held to be caused by special evil spirits.

From Hippocrates (460-359 B.C.) came the theory of the four humors which held the essential elements of the body to be phlegm, blood, yellow bile, and black bile and disease to result from the improper balance between these substances. Our vocabulary still bears testimony to this belief when we speak of people of a sanguine, phlegmatic, or melancholy temperament. And this is not surprising since the theories of Hippocrates and his follower Galen dominated medical thought until the 16th century.

We cannot be detained with a discussion of the various advances in thought between this period and the establishing of our present knowledge except to mention the work of Thomas Sydenham (1644-1689) who asserted that "a disease is nothing more than an effort of nature to restore the health of the patient by the elimination of the morbific matter." In his belief in a definite substance, the *materies morbi,* as the cause of the disease, the "English Hippocrates," as Sydenham has been called, took a definite step in advance and foreshadowed the scientific recognition of infective organisms in the classical researches of Pasteur.

Foreshadowings of the Present Theory.—Certain other scientific developments preceded the work of Pasteur. Most important was the development of the compound microscope about 1835. This was a necessary prerequisite to the study of infectious disease, as well as to the development of cytological and histological knowledge. In 1837 the Italian investigator, Bassi, discovered that a contagious disease of silk worms known as *muscardine* was caused by a parasitic fungus and only two years later (1839) Schoenlein showed another of these mold-like plants to be the cause of *favus* or honeycomb of the human scalp. Here then we received definite information of a parasitic plant as the cause of a human disease.

Fermentation and Disease.—It was in 1838 that Cagniard de Latour, and Schwann in studying yeast showed that alcoholic fermentation is caused by a living plant. Their theory that this plant was the real cause of the fermentation process was at first disputed and was only thoroughly and finally established by Louis Pasteur (in 1857-1863) who went still further and showed that the "diseases" of beer and wine (abnormal sour and bitter tastes) were produced by microorganisms other than ordinary yeast. These had invaded the liquid and interfered with the usual alcoholic fermentation by producing undesirable fermentations of their own.

It could hardly fail to occur to any thoughtful person that if this were true for certain diseases of wine and beer, it might well be true also for certain diseases of animals for if we consider step by step the course of any familiar fermentation and then do the same for any familiar infectious disease, we shall discover between them a remarkable similarity. For this purpose we may take the fermentation of apple juice, or cider, and smallpox. The juice of apples is heremetically sealed and kept from exposure to air by the apple skin. In the making of cider this skin is broken, the juice is pressed out and of course exposed to the air, to dust, to the press, to the sides of the vessel which received it, to the strainer through which it passes, etc. At first, and for some time the juice is sweet, insipid, unfermented, but after some time it is plain that a change is coming over it. This change is called the "working" or active fermentation of the apple juice, and a closer examination will show that it is accompanied by a slight rise of temperature or "heating" (which is a familiar phenomenon in many fermentations), as well as by obvious chemical changes resulting in the evolution of gas and the disappearance of sugar, in place of which alcohol makes its appearance, giving to the whole process the name of "alcoholic fermentation." The fermentation of any particular portion of apple juice, however, is not indefinitely prolonged. On the contrary, after a comparatively short time, the process comes to an end, the evolution of gases ceases, and rest supervenes. Since Pasteur's classical researches we know that what has really happened has been first, the seeding of the apple juice by (wild) yeast; second, the slow growth of this during the quiescent period; third, its active growth and "working" during the time of obvious fermentation; and fourth, its gradual cessation of activity during the final period. In the case of the infectious disease known as smallpox the history is usually as follows. A susceptible patient must first be ex-

posed to the disease, perhaps by contact with a person already affected, perhaps with clothing, letters, food or other materials handled by such a person. After such exposure there is for a time no marked change; but because the disease has been shown by repeated experience to be nevertheless gradually developing, as judged by the result and certain obscure premonitory symptoms afterward recalled, physicians have unanimously agreed to name this the period of incubation. Sooner or later, headache, malaise, and other troubles appear, the patient becomes seriously ill, a physician is called in, a rise of temperature or fever is discovered, the eruption and other marks of smallpox appear, and the patient is plainly affected by active disease accompanied by every indication of profound disturbance and chemical change. But at last, if death does not supervene, recovery ensues, and the patient gradually becomes free from the disease by which he was temporarily overcome. We may add that the barrel of apple juice can undergo the alcoholic fermentation once only, and that the smallpox patient likewise, as a rule, has the smallpox only once. If now we tabulate side by side and in order, the principal phenomena of an alcoholic fermentation such as that of apple juice, and those of an infectious disease such as smallpox, we shall discover a remarkable similarity between them.

A FERMENTATION (Apple juice)	AN INFECTIOUS DISEASE (Smallpox)
1. Exposure of the juice to air, dust, etc.	1. Exposure of the patient to infection.
2. Repose and then slow change. (Growth of the ferment.)	2. Incubation. (Slow and insidious progress of the disease.)
3. Active fermentation or "working." Evolution of gas bubbles, change of sugar to alcohol. Rise of temperature.	3. Active disease. Eruption, disturbance of the usual functions. Rise of temperature or fever.
4. Gradual cessation of fermentation.	4. Slow convalescence (or death).
5. No further liability to alcoholic fermentation.	5. Immunity to smallpox.

The striking analogy here shown suggests something more. It certainly justifies the suspicion of relationship, and shows well the natural fitness of the term "zymotic" (fermentative) for that class of diseases in which an analogy so remarkable is manifest.—*Sedgwick.*

Pasteur.—Just as Pasteur had finished his important studies upon the nature of fermentation in wine and beer, thereby opening for himself a broad and alluring field for

further research, he was urged by the French government to undertake the study of a disease of silkworms. This disease was not only causing an annual loss of 100,000,000 francs in France but it was spreading rapidly to other countries so that it threatened the existence of the silk industry in all parts of the world. Pasteur was at length persuaded to attempt a solution of this problem and during the year 1865-1868 he proved this disease (pebrine) to be caused by a particular germ which could be grown by itself in suitable liquid. He also devised a method by which the eggs could be hatched and the silkworms reared without becoming infected with this disease.

He had now definitely established the fact that certain minute plants (bacteria) were capable of producing particular fermentations or souring processes in beer and wine and that another similar organism was the cause of an infectious disease which had killed so many of the silkworms. These bacteria could be grown by themselves and separated from other organisms in a suitable liquid and would always produce their own particular type of fermentation or disease when put back in the proper place. The foundations for the science of bacteriology and the germ theory of disease were thus securely laid.

Lister.—Development from this point was rapid. Sir Joseph Lister, reflecting upon the significance of these investigations of Pasteur, concluded that many wound diseases were probably infectious and set to work by the use of antiseptic dressings, sprays, etc., to establish his thesis which paved the way for the modern practice of sanitary or aseptic surgery.

Koch and the Development of Bacteriology.—Then came the startling work of Robert Koch in 1875-78 who firmly established the science of bacteriology by his researches upon anthrax and other diseases and by the adaptation of solid cul-

ture media, prepared from gelatin substances, on which bacteria could be readily grown and isolated. In his work with anthrax or splenic fever, a disease then very common among cattle and sheep, and occasionally attacking human beings, he found, as others had already observed, that there were minute or microscopic rods in the blood of animals which had died from this disease. These minute plants he removed from the tissues and planted in the clear liquid which constituted the aqueous humor of the ox's eye. The organism grew in this liquid from which minute quantities were introduced into fresh aqueous humor several times in succession until only the remote descendants of the plants first used were left. When these were introduced into healthy animals they produced typical anthrax. In other words the chain of proof had been made complete. A particular germ had been found in animals having a particular disease, it had been isolated and grown by itself in pure cultures, it had been introduced into healthy animals where it produced disease and the death of the animal, after which it could be recovered from the tissues. These four steps are known as Koch's rules for identifying the cause of a disease.

The use of solid media in 1881 was followed by the discovery of the bacillus of tuberculosis in 1882, the discovery of the cholera vibrio in 1883, the bacilli of diphtheria and tetanus (lock-jaw) in 1884 and so on. The long list of diseases for which the causes are now known is evidence of the rapid growth of this field. We find diseases caused by a variety of microorganisms which are different in their appearance, their mode of living, and their effect upon the body. The list of infective organisms includes the round, the rod-shaped, and the spiral type of bacteria, fungous or mold-like plants like that producing honeycomb of the scalp and also animal parasites like those producing malaria and amebic dysentery.

PREVENTIVE MEDICINE

Preventive medicine may be properly limited to those processes by which the individual is so treated as to become immune to particular diseases, in other words, the treatment of the individual to prevent disease. We must look to Pasteur as the founder of this new science. In beginning his studies on immunity Pasteur had before him the example of smallpox vaccination which had been developed and successfully applied without knowledge of the germ theory of disease. Let us briefly review this story.

Smallpox and Vaccination.—As early as 1717 Lady Mary Wortley Montagu, the wife of the British ambassador at Constantinople wrote to friends at home of the Turkish custom of "inoculating" against this disease. In this inoculation some "matter" derived from the pustule of a smallpox patient was introduced under the skin of a healthy person. Such an individual by choosing inoculation at a time when in good physical health, had a mild attack of the disease and was immune thereafter. The general adoption throughout Europe of this strenuous method of securing immunity speaks for the horror in which the disease was held. Previous to that time smallpox was the great scourge and destroyer of mankind, hardly one person in a thousand escaped it and so common was it that nearly everyone took the disease while yet a child so that it was regarded as a children's disease.

Then came the wonderful discovery of vaccine by Edward Jenner in 1796. Jenner had been impressed as a student at Sudbury by the remark of a patient, in the person of a dairy maid, who said, "I cannot take smallpox because I have had cowpox." Testing this belief in his classical experiments Jenner transferred the vaccine virus from the eruption upon the hand of Sarah Nelms,—a dairy maid who had contracted cowpox from her master's cow by infection through a scratch in the hand,—to the arm of James Phipps, a boy about eight

years old. This successful vaccination was followed by exposures to see that it provided a complete immunity against the disease, smallpox.

Vaccination experiments were made elsewhere and in Boston, in 1802, nineteen boys were vaccinated with cowpox in an experiment by the Board of Health. Twelve of these boys were later inoculated with smallpox with negative results while two unvaccinated boys who were also inoculated with smallpox virus both took the disease. The conclusion of the Board of Health that "cowpox is a complete security against smallpox" we now know to be justified. By vaccination this great scourge has been practically eliminated. Indeed, so rare has it become, that even sensible, though unthinking, people forget the horror of the disease and give ear to those who oppose vaccination in spite of the fact that vaccination is now under almost perfect control and is the only sure prevention for smallpox.

The Immunity in Anthrax and Rabies.—But it remained for Pasteur to develop the principle of immunity and to apply it to other diseases. Applying the principle of germ disease to this phenomenon Pasteur reasoned that if the infectious disease is a struggle between a man and a microbe it is probable that in vaccination for smallpox the struggle is less severe for the patient, because the germs have been weakened or enfeebled through residence in the body of the cow. This suggested that disease germs might be weakened by heat, cold, dilution, starvation, etc., and Pasteur actually produced enfeebled or "attenuated" cultures of anthrax and chicken cholera by these means.

The story of his dramatic public demonstration of the practicability of vaccinating animals against anthrax or splenic fever is one of the most interesting in the history of science. Here he showed that animals which had been vaccinated with attenuated cultures of the bacillus were not subject to the disease after inoculation with virulent germs while animals which had not previously received such a vaccination

and had been inoculated with the same virulent germs met death at the hands of the disease.

The experiments began on May 5, 1881, at four kilometers' distance from Melun, on a farm of the commune of Pouilly-le-Fort, belonging to a veterinary doctor M. Rossignol, Secretary-General of the Society of Melun. At the desire of the Society of Agriculture, a goat had been substituted for one of the twenty-five sheep of the first lot. On the 5th of May they inoculated, by means of the little syringe of Pravaz,—that which is used in all hypodermic injections,—twenty-four sheep, the goat and six cows, with five drops of an attenuated splenic virus.

On May 31 very virulent inoculation was effected. Veterinary doctors, inquisitive people and agriculturists formed a crowd around this little flock. The thirty-one vaccinated subjects awaiting the terrible trial stood side by side with the twenty-five sheep and the four cows, which awaited also their first turn of virulent inoculation. Upon the proposal of a veterinary doctor, who disguised his scepticism under the expressed desire to render the trial more comparative, they inoculated alternately a vaccinated and a nonvaccinated animal. A meeting was then arranged by Pasteur and all other persons present for Thursday, June 2, thus allowing an interval of forty-eight hours after the virulent inoculation.

More than two hundred persons met that day at Melun. The Prefect of Seine-et-Marne, M. Patinot, senators, general counsellors, journalists, a great number of doctors, of veterinary surgeons and farmers, those who believed and those who doubted came, impatient for the result. On their arrival at the farm of Pouilly-le-Fort, they could not repress a shout of admiration. Out of the twenty-five sheep which had not been vaccinated, twenty-one were dead; the goat was also dead; two other sheep were dying, and the last, already smitten, was certain to die that very evening. The nonvaccinated cows all had voluminous swellings at the point of inoculation, behind the shoulder. The fever was intense, and they had no longer, strength to eat. The vaccinated sheep were in full health and gayety. The vaccinated cows showed no tumor; they had not even suffered an elevation of temperature, and they continued to eat quietly.—*Radot.**

Later Pasteur evolved a preventive treatment for rabies, a disease in which the causative germ was not known. In the "Pasteur treatment" for rabies spinal cords which are known to contain the germs of the disease are removed from infected

**Louis Pasteur: His Life and Labors.* By his son-in-law. From the French By Lady Claud Hamilton. New York, D. Appleton & Company, 1885.

rabbits and the strength of the virus is reduced by extended periods of drying. Then as now, the treatment was begun by introducing into a patient, which had been bitten by a rabid dog, an emulsion made from cord which had been drying for two weeks. On the following days the emulsion was made up from fresher and fresher spinal cord until that which had been dried only two days was administered. If administered first this would have produced rabies and death. The story of the first application of this treatment to a human subject in the successful treatment which Pasteur gave to the Alsatian boy, Joseph Meister, is of absorbing interest. (See Life of Pasteur quoted above.)

In the cases cited above the body became immune or able to combat successfully the virulent germs by first conquering the attenuated or weakened germs of each disease. We may defer for the chapter on Immunity the discussion of the weapons and methods of this struggle because the activities of the germs and the body are complex.

Diphtheria and Antitoxin.—Diphtheria is a disease, most common in early childhood, due to an invasion, usually of the throat, by a highly infectious organism. This is known as the Klebs-Loeffler bacillus in honor of the men who succeeded in isolating it in 1883. The disease is of special interest because a definite poison (toxin) is secreted by the germ just as alcohol is secreted as a metabolic product of the yeast cell. This toxin is extremely poisonous to the cells of the body.

In 1892 Berhing and Kitasato discovered that the blood of an animal which had been made immune to the toxin of diphtheria was able to neutralize or render harmless the toxin of the disease, while the serum of the nonimmunized animal could not. We now secure antitoxin from the blood of horses which have been made immune by injecting small and increasingly larger doses of toxin. When introduced into the body of the patient, antitoxin neutralizes the toxins

produced by the diphtheria bacillus; and if given early enough, it is a sure cure for the disease.

In 1913 Dr. Schick devised a test by which it is possible to discover whether or not a person has diphtheria antitoxin in his blood. A small amount of diluted toxin is injected into the outer skin. If the individual's blood contains antitoxin the toxin is neutralized and the test is negative. If the blood contains no antitoxin, which means that the person is susceptible to the disease, the small amount of the toxin sets up a slight local irritation and the small red spot which appears constitutes a positive test. Although persons vary markedly in susceptibility, the great majority of adults have been found to be immune. They have manufactured their own diphtheria antitoxin. Mothers transmit some of the antitoxin from their own blood to infants, the avenues being the placental circulation before birth and mother's milk after birth. This antitoxin in the blood is not of the infant's own manufacture and is soon thrown off in the discharges from the body. Exactly the same sort of thing happens when antitoxin is injected into the body of an older person to prevent diphtheria. The person is made immune for a time, but the immunity does not last long. The percentage of the population susceptible at various ages is shown in the accompanying table, based upon the extensive studies of Park in New York City.

Susceptibility Based Upon 20,000 Schick Tests

AGE	PERCENTAGE SUSCEPTIBLE
At birth	10% or less
Under 4 months	15% or less
Under 6 months	30% or less
6 to 9 months	60% or less
9 months to 1 year	75% or less
1 to 2 years	65% or less
3 to 5 years	40% or less
5 to 10 years	30% or less
10 to 20 years	25% or less
Over 20 years	20% or less

It is now possible to produce a lasting immunity against diphtheria by injecting into the skin a mixture of toxin and antitoxin. Three doses are given one week apart. The antitoxin subdues the irritating effects of the toxin, but the latter acts upon the cells of the body and causes them to produce their own antitoxin. During the last decade hundreds of thousands of children have been immunized with toxin-antitoxin and, so far as is known at present, this immunity is permanent.

Further consideration of the subject of immunity is presented in a later chapter. The material already presented indicates the nature of some of the scientific developments in the field of preventive medicine.

PREVENTIVE SANITATION

We have spoken of the new knowledge of germs as the cause of disease and the development of the principle of immunity, which forms the basis of preventive medicine. The second great division of this new science of disease prevention is preventive sanitation.

The knowledge that diseases were produced by germs and that the spread of disease is due to the infection of the healthy individual with these living germs makes it clear that for self-protection society must prevent the voiding of germs by the diseased person where they will be picked up by other individuals. The responsibility of society was recognized even before the development of the germ theory of disease was well established, for as early as 1874 there was a belief among experts that "the existence of specific poisons capable of producing cholera and typhoid fever is attested by evidence so abundant and strong as to be practically irresistible. These poisons are contained in the discharges from the bowels of persons suffering from the disease." (Rivers Pollution Commission of 1868, Sixth Report, London, 1874.)

The Epidemic of the Broad Street Well.—One of the foundation stones for this belief was laid in the excellent work of Dr. John Snow of London in 1854, in investigating an epidemic of Asiatic cholera, which was traced to the water of the Broad Street well. Inasmuch as this was the beginning of the science of epidemiology we may briefly give it our attention.

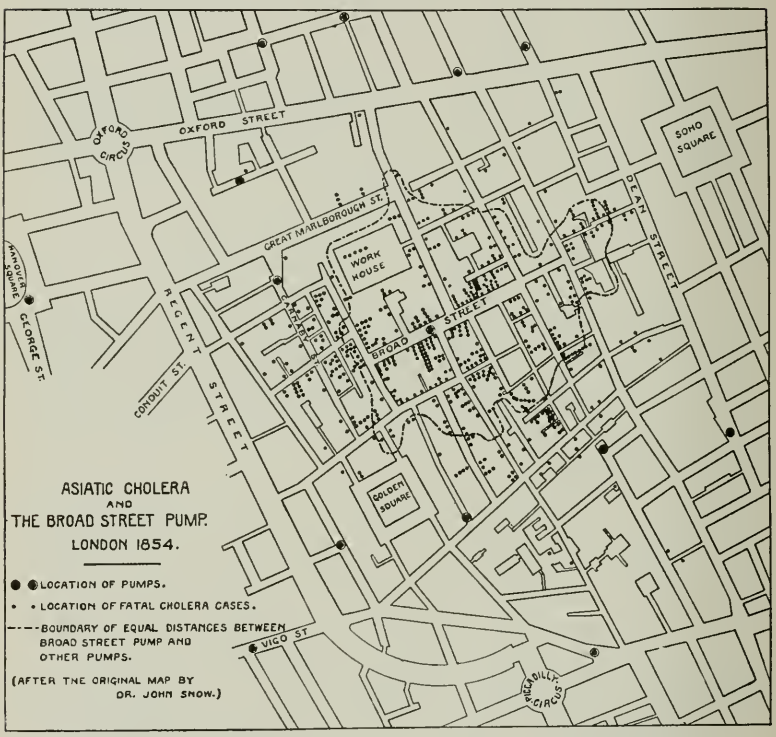


Fig. 30.—Cholera deaths in the epidemic of the Broad Street Well.

During the epidemic the death rate in St. James Parish was far higher than that for any other district. Moreover the deaths were unequally distributed and had nearly all taken place in the vicinity of Broad Street. It appeared therefore, that there must be some other factor involved than the

usually accredited causes of epidemics, such as meteorological conditions, the general impurity of the air, the nature of the soil and the density of the population. From the beginning of the outbreak Dr. Snow had taken the trouble to get the number and location of all the fatal cases. He found that 83 deaths took place during three days beginning with August 31. To quote from his report:

On proceeding to the spot I found that nearly all the deaths had taken place within a short distance of the pump in Broad Street. There were only ten (10) deaths in houses situated directly nearer to another street pump. In five (5) of these cases the families of deceased persons told me they always sent to the pump in Broad Street, as they preferred the water to that of the pump which was nearer. In three other cases the deceased were children who went to school near the pump in Broad Street. Two of them were known to have drunk the water, and the parents of the third think it probable that it did so. The other two deaths beyond the district which the pump supplies represent only the amount of mortality from cholera that was occurring before the eruption took place.

With regard to the 73 deaths occurring in the locality belonging, as it were, to the pump, there were 61 instances in which I was informed that the deceased persons used to drink water from the pump in Broad Street, either constantly or occasionally. In six (6) instances I could get no information, owing to the death or the departure of every one connected with the deceased individuals; and in six (6) cases I was informed that the deceased persons did not drink the pump water before their illness.

The result of the inquiry consequently was that there had been no particular outbreak or increase of cholera in this part of London, except among the persons who were in the habit of drinking the water of the above-mentioned pump well.

I had an interview with the Board of Guardians of St. James Parish on the evening of Thursday, 7th of September, and represented the above circumstances to them. In consequence of what I said the handle of the pump was removed on the following day.

Among the unusual causes which added confirmation to this belief Dr. Snow describes two as follows:

A gentleman in delicate health was sent for from Brighton to see his brother at No. 6 Poland Street, who was attacked with cholera and died in twelve hours, on the first of September. The gentleman ar-

rived after his brother's death and did not see the body. He only stayed about twenty minutes in the house, where he took a hasty and scanty luncheon of rump steak, taking with it a small tumbler of cold brandy-and-water, the water being from the Broad Street pump. He went to Pentonville and was attacked with cholera on the evening of the following day, September the 2nd, and died the next evening. * * * *

The deaths of Mrs. E—— and her niece, who drank the water from Broad Street at the West End, Hampstead, deserve especially to be noticed. I was informed by Mrs. E—'s son that his mother had not been in the neighborhood of Broad Street for many months. A cart went from Broad Street to West End every day, and it was the custom to take out a large bottle of the water from the pump in Broad Street, as she preferred it. The water was taken out on Thursday, the 31st of August, and she drank of it in the evening and also on Friday. She was seized with cholera on the evening of the latter day, and died on Saturday. A niece who was on a visit to this lady also drank of the water; she returned to her residence, a high and healthy part of Islington, was attacked with cholera, and died also. There was no cholera at this time, either at East End or in the neighborhood where the niece died. Besides these two persons only one servant partook of the water at West End, Hampstead, and she did not suffer, or, at least, not severely. She had diarrhea.

The investigation was further continued by the Rev. H. Whitehead who studied the cause of the sudden pollution of the Broad Street well which he believed must have been the cause of the epidemic referred to above. He found that in house No. 40 Broad Street there had not only been four fatal cases of cholera at the time of the epidemic but there had been earlier cases of an obscure nature which were probably cholera, and that the dejecta from these had been thrown into a cesspool very near the well. Further investigation showed that the bottom of the main drain from this house lay 9 ft. 2 in. above the water level and that one drain was so broken down as to leak like a sieve. Moreover, the poorly constructed cesspool over which a common open privy had been placed connected with the drain. The walls of the cesspool were in the same leaky condition and the removal of the soil showed that there had been a direct drainage from both

cesspool and drain into the well. The water had apparently been long polluted but it required a specific infection to produce the outbreak of Asiatic cholera.

Thus water-borne disease was known to exist before it was known that the disease was produced by germs. In other words, at this time it was believed that *filth* produced certain diseases because it produced, harbored and developed certain poisons instead of furnishing, as we now know to be the case, a temporary abode for the germs which have been thrown off from the body of a previous case of the disease.

We might describe other epidemics of intestinal disease which have been traced to polluted water before and after the discovery of the germs of these diseases. To this we could add the story of scores of epidemics of typhoid fever, scarlet fever, and diphtheria, which have been traced to milk and the description of various other methods of infection by means of food or some other intermediate substance.

A Typhoid Fever Epidemic From Oysters.—Perhaps one of the most famous epidemiological investigations on record is that made by Professor H. W. Conn of Wesleyan University in 1894. In this year there was an outbreak of typhoid fever about October 20 which included over twenty cases among the men of this coeducational college. No common bond was found among the victims of the disease. They boarded at different tables and many lived in private houses in town. The wells of the college campus were excluded on the ground that they were used by town people as well as college students and no typhoid fever had occurred among the townspeople.

Professor Conn's complete and careful studies developed along the lines indicated by the following facts. With three exceptions all the sick men belonged to three fraternities. There were no cases among the women of the college. The water, ice cream, butter and fruit eaten at these fraternity houses were all excluded as sources of the disease because they had been used by other people in the town and college. The

study of the dates showed that infection took place about the time of a series of fraternity suppers. One of the cases not belonging to a fraternity had attended such a supper. The menu of these suppers were studied and all foods excluded except raw oysters. It was then found that the women of the college did not hold any special supper on this date and did not eat raw oysters. Of the other four fraternities, among which there were no cases, two did not use oysters at initiation suppers, one obtained them from Hartford instead of Middletown dealers and the fourth used oysters but in the cooked and not the raw state. None of the families in town which bought oysters from this lot had eaten them raw. An attendant who had eaten oysters from this batch in the home of the dealer had had a mild run of the fever. Many alumni and five Yale students were present at the banquet. Among these there were several cases of slight illness, diarrhea, weakness, and four cases of genuine typhoid fever. Two of the five Yale students developed the disease.

The study of the source of the oysters showed that they had been taken from deep water in Long Island Sound, had been brought to the mouth of a creek near Fair Haven, Connecticut for fattening. Three hundred feet from the beds where the oysters were fattened there existed the outlet from the sewer of a private house in which there were two cases of typhoid fever. The current of water at this point showed that the effluent from this sewer would almost certainly be distributed over the beds in which the oysters were fattened.

These examples of the early and startling discoveries of the transmission of disease from the sick to the well by means of some intermediate substance show the basic principle upon which the science of preventive sanitation has been developed.

The knowledge of germs as the cause of disease, their viability in water, milk, and other foods, and the methods by which they may be destroyed has made it possible to develop

scientific means of sewage disposal, water purification, and the protection of food materials. The practical details of applied sanitation in these various fields will be later considered.

PREVENTIVE HYGIENE

Preventive hygiene or the conduct of individuals in such a way as to avoid infection and communicable disease is based upon our knowledge of both preventive medicine and preventive sanitation. Our habits are now influenced by our knowledge of the germs of particular diseases, their mode of life and the manner in which they may be transferred; so that in our daily activities we avoid opportunities for infection. Promiscuous kissing, the use of common drinking cups, and the eating of food prepared and served by people of uncleanly habits whose freedom from infectious disease cannot be vouched for; these and many other unhygienic habits are automatically condemned by our knowledge of germ diseases. These dangers of infection will be considered further in our discussion of special diseases.

Resistance.—Preventive hygiene must consider still another feature in resisting infection and particularly in successfully withstanding an infectious disease. Pasteur demonstrated that the outcome of the battle between man and the microbe may be determined by weakening or attenuating the latter or by building up a specific resistance of the human body. Dr. Theobold Smith has spoken of disease in terms of the formula $D = \frac{NV}{R}$; when D = the disease; N = the number of organisms in the initial infection; V = the virulence of the germs; and R = the resistance of the individual. This resistance in many cases is specific for the disease in question but for other diseases, like tuberculosis, the resistance may be related to the bodily vigor and general health of the individual. So that personal hygiene, which assists in building up a strong and healthy body, is related to disease prevention and is important in disease as well as in health.

Modern Health Services

According to Glenn Frank *(Surgery, Gynecology and Obstetrics),* "We are in the midst of adventures in disease prevention and life prolongation; and, in addition to powerful private economic interests making for a vast disease-preventive program, there is a growing social conscience respecting the issues of health and disease, a growing social conviction that the health of the social order is importantly interlocked with the health of its citizens.

"We seem to be drafting a new definition of treason. The American public is about ready to agree with Lord Palmerston that 'for every death from typhoid fever somebody should be hanged.' "

It is true that in the past there has been little civic responsibility for the maintenance and promotion of health measures, but this is no longer true. New types of health service are now available, not only to the very rich and the very poor, but also to the man of moderate means. Medical science and medical service are becoming organized more and more in the interest of the health of the people. These adventures in disease prevention and life prolongation were given a tremendous impetus by the tragedy of the world war.

The Child Health Center.—The year 1919 was set apart as Children's Year, and a vigorous campaign was pursued by the United States Children's Bureau, the American Red Cross, the Council of National Defense, and other patriotic organizations. Following the revelations of this year's work Congress provided for a five-year demonstration (later increased to seven), by which the Children's Bureau was enabled to cooperate with state health departments in the organization of divisions of child hygiene. This increased the demand for public health physicians and nurses, and child health centers are now established in several thousand cities and counties.

The function of these centers is educational. A wealth of helpful literature is distributed to the farthest corners of the country; children's health conferences are held in communities, large and small, where parents come to discuss the care of mothers and young children. Thousands of expectant mothers are induced to place themselves under proper care, hundreds of thousands of young children are examined and practical instruction is given for their better hygiene. Little mothers' leagues are formed, that mothers of the coming generation may be wiser than those of the present day. Classes in midwifery are formed for the training and supervision of midwives in rural sections where medical aid is often impossible to obtain. The project has proved a logical stepping stone to the more general health center.

Community Health Centers.—Another forward step in the organization of health services is the development of the community health center which seeks to house under one roof the various public health activities of the district. The activities of the health centers vary considerably, but they generally include both preventive and curative activities. The activities are likely to include the work of various divisions of the health department and the work of local organizations, such as the Red Cross, the Visiting Nurse Association, and others interested in public welfare and different types of clinics. A splendid description of health center activities is to be found in the following statement by Dr. Philip S. Platt *(Nation's Health)*, concerning the center at New Haven:

"The activities of the Health Center fall into two groups: those which are definitely attacking disease and those which are endeavoring to conserve health. In the attack upon disease the Health Center is officially delegated by the Health Department with the responsibility for the control of communicable disease. It is caring for the bed-ridden sick through generalized, localized, visiting nurses. The early recognition by means of physical examination of con-

ditions needing medical attention, and the bringing of the individual needing medical care in touch with his doctor or dispensary, is a direct attack upon disease in its earlier stages.

"The effort to conserve health in the healthy is made through the physical examinations of well people, through readily available health consultations, through well baby conferences and the prenatal clinic, through special classes, through educational work of health talks, leaflets, posters, lantern slides, and window exhibits. The supervision of the health of the school child by the school nurses, the medical inspection of the children (children absent from school more than three days are medically examined at the Health Center before being permitted to return) and the far-reaching educational work of the school nurses, the dietitian, the dental hygienist, and sanitary inspector are further health constructive measures. The use of prophylactic measures to protect against disease is slowly being accepted by the district."

The Pay Clinic.—For many years free clinics in connection with hospitals and other institutions have relieved vast numbers of people who could not afford private physicians. Men in more comfortable circumstances were neither eligible nor willing to accept free service. Often the man of moderate means found increasing difficulty in meeting the expense of even an occasional illness.

The Pay Clinic seemed a possible solution of the problem. In 1913 Boston Dispensary ventured to open a pay dental clinic in order to meet the commonest defect in their school children. In 1921, the medical school of Cornell University offered a generalized clinical service in New York City, charging patients enough to cover salaries of expert specialists, of maintenance and equipment. An average annual attendance of 20,000 indicates the extent of public response.

Hospitals and other institutions are following suit and many such clinics are now in operation. Some are for pre-

ventive purposes, others are for frankly curative purposes. They include the dental clinic, the children's clinics, tuberculosis clinics, and those for crippled children. There are clinics for the heart, the eye, ear and throat, and for mental and nervous cases.

Other Organized Health Services.—Many other forms of organized health service have found a place in modern society. We can mention only a few of the most important ones. Industry is extending the health service available to employees as a suitable and proper relationship between the employer and the worker. The health program of the public schools is becoming better organized in its sanitary, educational, and corrective aspects. The subjects of school health and industrial health are both considered in some detail in later chapters.

Life insurance companies are very properly concerning themselves with health and longevity. They are leading their policy holders to secure skilled medical and nursing service. They are making a most valuable contribution to public health education by placing at the disposal of the general public an enormous amount of valuable educational material. Definitely beneficial results are being obtained. During a recent eleven-year period while the length of life of the average American citizen was prolonged five and one-half years, the life of the average policyholder of one company was prolonged eleven years. (Frankel & Armstrong, *A Popular Encyclopedia of Health.*)

Still other activities in this line are seen in the work of the Life Extension Institute which provides skilled physical examination service in many cities, in the extended health services in our colleges and universities, and in the health activities of some of the trade unions.

Summary.—We have seen the origin of three united sciences by referring to the history of disease prevention and the discovery of germs as the cause of disease.

Preventive Medicine reaches back to the experiments of Pasteur in producing immunity to a specific disease. It includes all the more recent developments of this art by the use of specific vaccines, antitoxins, viruses, and drugs to assist the person to throw off or withstand infectious diseases. *Preventive Hygiene* recognizes the infectious agents of disease and prescribes such courses of individual conduct as are best calculated to avoid personal infection. *Preventive Sanitation* acts upon this knowledge of disease causation and prevents the spread of infection from the sick to the healthy through quarantine, the supervision of water, milk, and other food supplies, the purification of sewage, and the prevention of other conditions which would make it possible for live germs to reach and infect healthy individuals. These sciences together with the art and science of curative medicine are being rapidly organized for further service in our complex social organization.

CHAPTER IX

COMMUNICABLE DISEASES

Based upon the scientific facts which came to us with a knowledge that certain diseases are produced by minute living plants or animals which invade the human body, we were able to develop the practice of preventive medicine, preventive sanitation, and preventive hygiene. Let us now turn our attention to these diseases themselves in order to see something of the application of the principles of disease prevention.

The physician and the sanitarian must have a very definite, complete and exact knowledge of each communicable disease and the important facts concerning its spread. (Some of these facts are briefly stated in Appendix A.) Every individual, however, both for his own welfare and for the intelligent fulfillment of his responsibilities of citizenship in maintaining efficient public health administration, wishes to know something of the nature of these various types of communicable diseases. What living organisms cause them? What is the nature and life history of these parasites? How are they carried from the sick to the well? What kind of relationships do the small plants or animals establish with the human body? How can we *miss* these diseases instead of *catching* them?

The Interrelationship of Plants and Animals.—Few phases of biology can be more interesting than the relationships of plants and animals to one another. Every species of living thing is given by inheritance a particular structure, and to continue life it must adapt itself to its environment. It must secure suitable food. From the ways in which food is secured we may divide all living things into two groups, the independent and the dependent. The green plants are

said to be independent, capable of self-nourishment or autotrophic because with the aid of sunlight they are capable of manufacturing their own food from the inorganic substances of soil, water and air. Animals, on the other hand, are dependent in that they must have their food already manufactured. They feed upon the fruit or tissues of plants, upon the flesh of other animals, or upon the fluids or organic products of these plants or animals. There are also many plants which are dependent. The fungi (molds and bacteria) are characteristically dependent upon organic rather than inorganic substances for their food supply.

Almost every living thing (man included) is sought as a source of food by some plants or animals, which are its natural enemies. Among the plants and animals which look to us human beings as a source of food one can easily separate three different groups.

First, there are such insects as the mosquito, or the bedbug, and such larger animals as the wolves or tigers which occasionally attack man to secure food. Such an attack is an unusual thing, and there is no continual relationship.

The second group includes organisms known as *saprophytes* which secure their food from nonliving substances. The common intestinal bacteria present a good example of this relationship. If we think of the body as made up of one tube inside another we think of these intestinal bacteria as not being in the body proper, but as being in contact with the "inner skin." Within the intestines there are always millions of bacteria, of which the most common is Bacillus coli. Such bacteria live in the intestine without producing disease and under normal conditions without producing harmful results. Experiments indicate that animals can live without any bacteria in the intestines. Some chicks which were very carefully hatched under aseptic conditions were kept for many days upon sterile food, and it was found that the contents of the intestines were sterile. Under natural conditions, however, the intestines of all ani-

mals contain great numbers of these ordinarily harmless saprophytic organisms which live upon the partly digested food without injuring the animal in which they are found.

The third group of organisms are the parasites. This word literally means "to sit at the table beside another," and among the Greeks it had much the same usage as our term "social parasite" has at present. In biology a parasite is defined an organism which lives in or upon the body of another (called the host) to the disadvantage of the latter. The bacillus of typhoid fever, like the colon bacillus, grows in the human intestine but it is definitely disadvantageous to the host. It produces substances injurious to the body and destroys the body tissue with which it comes in contact. The Bacillus typhosus is a disease producer, a parasite; the Bacillus coli is a harmless saprophyte.

Organisms which Cause Disease.—These parasites which produce disease in or upon the body are of many different kinds. They include single cell animals, worms, insects, bacteria and moulds. Every organism differs in its life processes, its attack upon the body and in the effect produced. There is naturally also a difference in the way in which the various parasites are transmitted from the body of the infected person to the body of the well person. We might indeed classify the communicable disease according to the kind of parasite which causes the disease, placing the bacterial diseases in one group, the worm diseases in another and so forth. We might, on the other hand, classify these diseases according to the part of the body which is infected, separating them into diseases of the blood, diseases of the digestive tract, diseases of the lungs, and so forth. For purposes of public health, it may be most logical to classify diseases according to their mode of entering the body. This puts them into a more or less natural grouping with similar methods of control for the diseases in each group.

We recall in the analogy between the fermentation of apple juice and a communicable disease that in both cases the organism must find its way inside the protecting covering of the skin. So long as the skin of the apple is intact, its juices are protected from the attack of the yeast cells. Similarly the body is protecteed by the outer skin and by the membranes or "inner skin" lining the breathing passage, digestive tract and the urogenital tract. We might divide communicable diseases into two groups—those which find their way into the body proper through the outer skin, and those which find their way into the body through the inner skin. On the whole, however, perhaps the most practical classification according to the mode of infection is to form four groups:

1. The *Alimentary* group of diseases in which the infective agent leaves the body in the urine, feces and other discharges and produces disease through the alimentary tract.
2. The *Inoculation* group of diseases in which the infective agent is conveyed by biting insects.
3. The *Respiratory* group of diseases in which the infective agent is carried to the respiratory tract by "droplets," scales of skin or discharges of the nose and throat.
4. The *Contact* group of diseases which are spread either directly through contact with an infected person or animal or with infected material.

The Alimentary Diseases.—In this group of diseases the infecting organism finds its way into the body along the digestive tract. Some of these diseases are produced by bacteria, others are produced by parasitic worms, and at least one (amebic dysentery) is produced by the protozoan or single cell animal, Ameba histolytica.

Among the bacterial diseases we find such important infections as cholera, typhoid fever, and bacillary dysentery. The organisms producing these diseases take up their abode in the intestines and are present there in enormous numbers throughout the course of the disease. Consequently,

they are present in the excreta and may be carried to well people by contaminated water or food. The spread of these diseases is also extended because of the presence of "carriers,"—apparently healthy people who have either recovered from the disease without having eliminated all of the organisms or who have become infected with the disease and, although harboring the virus, are not made clinically ill by it. From these people as well as from the more seriously ill, the organisms from the discharges find their way to food or drink and thus to the intestine of a well person. They may be transmitted to the hands and then to the mouths of well people by direct contact, and by the handling of articles soiled by the discharges of patients, or they may be carried mechanically upon the feet of flies from one person to another. The accompanying chart prepared some years ago by Professor Whipple shows in an excellent manner the methods of transmission for one of these intestinal diseases and the barriers which are set up against the spread of the disease. (Fig. 31.)

Among the *worm diseases* we find trichinosis, hookworm (anchylostomiasis) and tape worm disease, each having a mode of transmission dependent upon that part of the life history of the parasite which takes place outside the human body.

Most of the worm parasites which infect man also infect some other animal. The roundworm which produces trichinosis, and the various tape worms come to man encysted in the muscles of animals used as food. (See chapter on Food Control.) Sanitary measures in these cases are to prevent the use of infected animals as food and to encourage the thorough cooking of meat in order that the parasites may be killed if present. In hookworm, on the other hand, the bowel discharges of the patient contain great numbers of eggs. These eggs develop into larvae which infect the ground. They may enter the mouth in drinking water or solid food, but usually they pierce the skin of the hands or

feet, pass through the lymphatics to the blood stream, and thence to the lungs. Here they pierce the walls of the air sacks, are passed up the breathing tubes to the throat, from whence they are swallowed and lodge in the small intestines to grow and reproduce. We check this disease by preventing the spread of the infective organism from the body discharges. We provide sanitary privies for the prevention of soil infection, kill the organism by use of salt in latrines or in infected soil, and safeguard our water supplies from picking up and conveying these parasites.

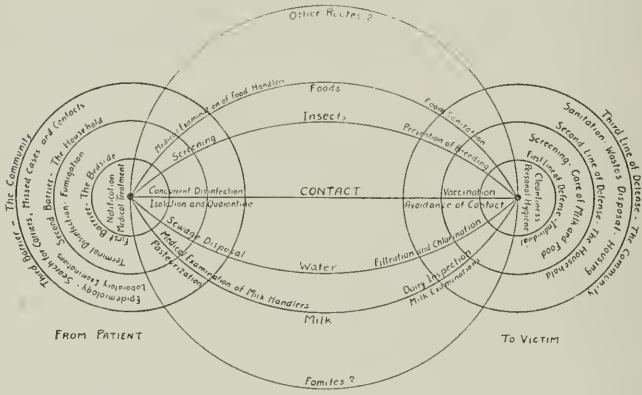


Fig. 31.—Whipple's chart showing modes of infection in typhoid fever and the barriers against its spread. (As modified by Luckett and Gray.)

Inoculation Diseases.—The transfer of disease by inoculation is by the entrance of its virus through the skin or flesh. For an indefinite period man has recognized the hostility of a variety of biting insects which were always ready to disturb his comfort whenever the opportunity to attack him arose. The mosquito is eager to draw his food from man's blood supply. If human habitations are sufficiently unsanitary, the bedbug takes up his abode in the house, with its program of watchful waiting and sudden action. If man's habits of personal cleanliness are sufficiently poor,

the louse lives upon his body and becomes an external parasite. The itch-mite burrows into the skin of man producing redness, itching and irritation. But not until 1879 was it suggested that any of these insects in their feeding upon man could bring him disease-producing germs.

The studies of Sir Patrick Manson upon a tropical disease known as filariasis showed that the blood of patients suffering from this disease contained in great numbers the young form of a certain kind of worm. He suggested and later was able to prove that this worm is drawn from the blood when a mosquito bites an infected person, passes part of its life in the body of the mosquito, and reaches a new human victim when the latter is bitten by the mosquito.

General attention was first definitely centered upon insects as possible carriers of diseases in 1893 by the conclusive studies of Dr. Theobald Smith upon Texas fever, a disease of cattle. He showed that the blood parasite (Babesia bovis) lives in the body of the infected tick and is transferred to cattle by the bite of the insect.

From these investigations we recognized a new means of disease transmission,—namely, the *biologic*. By this we mean that the germ which produces the disease passes part of its life history in the body of some other animal which acts as a temporary host. In many cases, the temporary existence in the body of this other host is necessary for the complete development of the parasite, and the germ cannot be transferred back to man until it has passed through certain stages of development in the body of the insect. Insects responsible for the biological transmission of an infection are known as *vectors* of disease. This must be quite clearly distinguished from the mechanical transmission of disease which might take place because of house flies or other insects which travel over infectious material. They may collect the germs of typhoid, cholera, dysentery or some other disease upon their feet and legs and carry the germs to a healthy individual or to food which is about

to be eaten, thereby transporting the causative agent of the disease in a purely mechanical fashion.

Further research has taught us that malaria, yellow fever, filariasis, dengue, plague, African sleeping sickness, and Rocky Mountain spotted fever, together with a few less important maladies are conveyed to man by biting insects. Usually the virus of the disease is capable of living in the body of the particular insect in question without injuring it. When transferred to man, the virus atacks some particular part of the body or by its presence produces fever, and tissue destruction.

There are several possible points of attack in the elimination of such diseases. We may undertake measures for the eradication of the insect which carries the infection, we may keep the insect away from the sick, in order to prevent their becoming infected, we may use precautions of screening and the eradication of vermin in order to keep man protected from attack and the bite of the insect, or in some cases we may attack the virus itself—as we do in the case of malaria by the use of a specific substance, quinine which kills the developing organism in the blood of the human patient. The entomologist and the sanitarian, from a knowledge of the life history and habits of the insect, suggest the methods by which it can best be attacked. Our general program in most of these diseases includes all of these means of restricting the disease: prompt diagnosis and treatment of the patient under suitable isolation, a campaign against the insects themselves, and the protection of the healthy population by education and cleanliness.

Mosquito-Borne Diseases.—Among the various insects which act as vectors of disease the mosquito easily ranks first in importance. Dengue fever and filariasis are moqsuito-borne diseases, but the two which have caused most attention and which have been most important as causes of disability and death are malaria and yellow fever. No stories in the his-

tory of sanitary science are more interesting than the development of our knowledge as to the cause of these diseases.

Malaria in both ancient and modern history has been one of the world's greatest scourges. It has been seriously suggested that this disease more than any one cause accounted for the downfall of the Greek Empire. It was always to be found in certain localities in warm countries, particularly in cities situated in low and swampy areas. In Italy certain

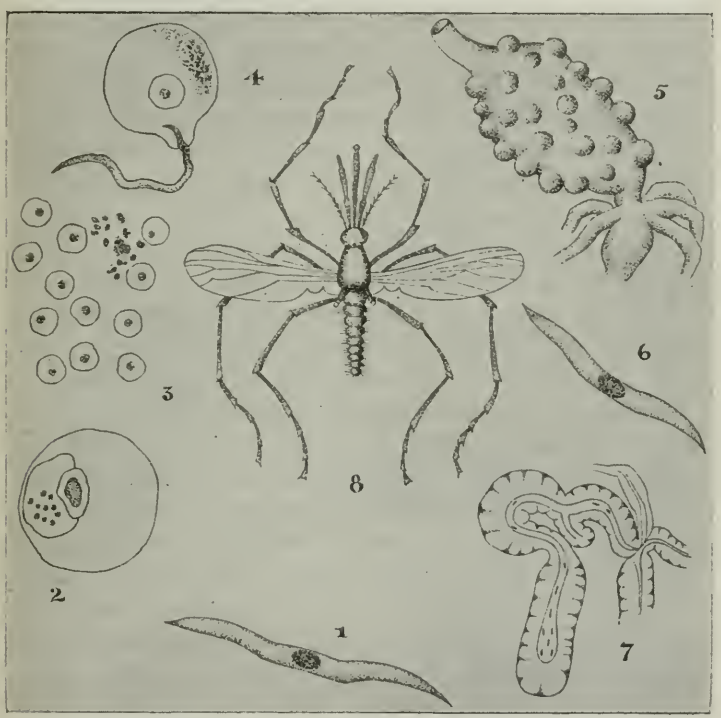


Fig. 32.—Life history of a malaria parasite. *1*, Malaria parasite (highly magnified) in the form in which it goes into the blood of man from the mosquito; *2*, a red blood corpuscle in which the malaria parasite is living; *3*, a group of young parasites which have been produced in the blood; *4*, the union of the male and female gametes which takes place in the body of the mosquito; *5*, picture of the stomach of the mosquito showing swellings caused by the growth of the malaria parasite; *6*, a single parasite as it comes from the stomach of the mosquito and makes its way to the mosquito's salivary gland; *7*, a section through the salivary gland of the mosquito from which the parasites get into the human body when the mosquito bites its victim; *8*, female malaria mosquito.

valleys like the Campania were filled with infection and the name malaria, meaning "bad air," reflects the general belief that the humid swamp air produced the disease.

Although Laveran, the French scientist, had previously found in the blood of malaria patients the single cell animal, known as the Plasmodium, which causes the disease, it was Ross (1895) who first discovered its transmission by the mosquito. Later studies showed the mosquito to be the only agency of transmission. To test out the mosquito theory Sambon and Low of the London School of Tropical Medicine went to Italy (1900) and lived in the "bad air" of a malarial locality for three months without contracting the disease. They escaped infection by remaining in their carefully screened hut from before sundown to after sunrise. Some mosquitoes which had bitten a malaria patient were later brought in a cage from Italy to London and allowed to bite healthy individuals (Dr. Manson and Mr. Warren) who straightway came down with the disease. Since then the complete life history of the parasite has been worked out and it has been learned that certain stages of its life history must be passed in the body of the mosquito, and that the disease goes from the sick to the well only through this agency. Moreover it is only a particular kind of mosquito, the Anopheles, which harbors and transmits the malaria germ. More than this it is only the female of the species which is the dangerous agent. The male mosquitoes are not blood sucking but feed upon vegetable juices. The females *must* feed upon blood in order to complete their development to the point where reproduction is possible. Thus the desire for blood sucking on the part of the female mosquito is linked with ordinary hunger and with the sex instinct.

Yellow Fever was added to the list of insect-borne diseases in 1900 by the distinguished work of the American Yellow Fever Commission composed of Reed, Carroll, Lazear and Agramonte. This disease also is conveyed by a single species of mosquito (Aedes, formerly called Stegomyia).

In 1902 *dengue* was found to be transmitted by the mosquito and as we have seen *filariasis* has been known to be transmitted by various species of mosquitoes for a much longer period.

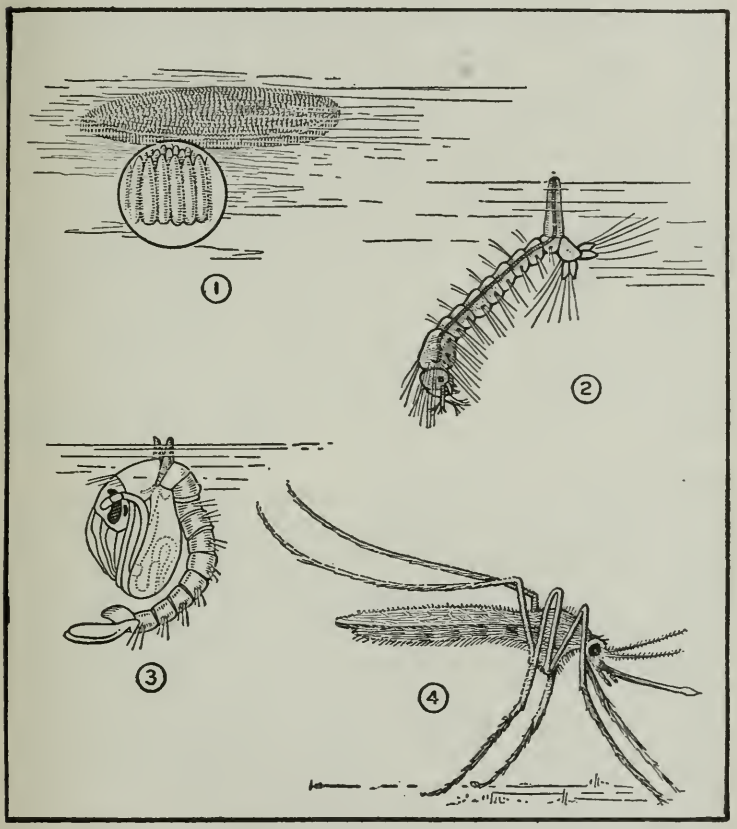


Fig. 33.—Life history of the mosquito. *1*, Mosquito eggs floating in water (shown slightly magnified); *2*, mosquito larva or wiggler; *3*, mosquito pupa or tumbler; *4*, full-grown mosquito. (From Turner and Collins: *Community Health*, D. C. Heath & Co.)

Mosquito Control.—It has been demonstrated in many communities that systematic and scientific programs of mosquito control, if sufficiently broad in scope and carried over

a reasonable period, may nearly or completely rid a community from mosquito-borne disease. It seems possible, indeed, that by the use of such procedure all mosquitoes infected with yellow fever may be killed and the disease may be entirely eliminated from the world.

The best method of attack upon the mosquito is the destruction of the larvae. This insect lays its eggs in the water. After one and a half days the eggs hatch into the larvae or "wigglers." During the larval period, the insect eats almost continually. Although living in the water it is air breathing. A breathing tube extends through a long projection at the posterior end of the body, and when air is taken in, this projection is thrust through the surface film of water. After six or seven days the pupa stage develops. During this period the insect eats nothing, it breathes through two tubes situated in the upper part of the thorax. This stage undergoes transformation during a period of about two days and the matured insect is formed. The pupa case is broken open along the back, the mosquito crawls out upon this floating skin and flies away.

An anti-mosquito campaign involves first an attack upon the breeding places. These may be eliminated by developing systems of drainage, and by making smooth sides of the banks of streams thus eliminating the grass growing in the water near the shore in which the insects can hide from their natural enemies. The campaign may be carried on in water which cannot be drained by the use of crude oil or larvacide. Crude oil spread over the surface makes a film through which the breathing tubes of the developing insect cannot penetrate, and the result is that the insect must die for want of air. The use of larvacide made of crude carbolic acid, resin, and caustic soda provides a means of poisoning and killing the larval forms. This procedure is less used, however, than the oiling process. Proper screening prevents mosquitoes from entering dwellings and thereby protects well persons, and proper screening of the sick prevents the infection of mosquitoes.

Other Insect-Borne Diseases.—Another disease which is usually transmitted by an insect is *plague.* This is primarily a disease of rodents but it is communicable to man. Plague swept over Europe about the middle of the fourteenth century, and from available records it apparently killed about twenty-five million people or one-fourth of the entire population. This epidemic is known in history as "Black Death." The disease is spread (except in the pneumonic form) by the bite of the *rat flea.* This flea picks up the virus from an infected rat and spreads it to other rodents or to man.

In a campaign against plague, therefore, in addition to the isolation and specific treatment of infected cases, we have as a most important general procedure the campaign against the rat, involving trapping, killing, preventing rats from entering countries or cities from ships, rat-proof construction in the building of houses and commercial buildings, the use of cats and other natural enemies, and the covering of garbage in an attempt to eliminate the natural food supply of the rat.

It has been proved that the body *louse* transmits *typhus fever* and *relapsing fever.* Ridding infected people of lice and the development of sufficiently cleanly habits of living to prevent the spread of lice among the population is a fundamental procedure in eliminating the disease. Other insects which convey disease are the *Tsetse fly* which conveys *African sleeping sickness,* the *tick* which conveys *Rocky Mountain spotted fever, relapsing fever,* and *Texas fever* (in cattle). In all these diseases a scientific sanitary program of prevention can be built by an attack upon the insect in question.

Respiratory Diseases.—There is another large group of diseases in which the virus is transmitted through the secretions of the mouth and nose. In such a group we may place smallpox, chickenpox, cerebrospinal fever, tuberculosis, measles, German measles, mumps, diphtheria, scarlet fever, influenza, whooping cough, pneumonia and perhaps leprosy. In the case of smallpox and chickenpox the bodily discharges

like the scales of the skin may also transmit the disease. But in most cases, the nasal or oral discharge is of primary importance. The breath if it is quietly exhaled is sterile, but in the transmission of these diseases *coughing* or *sneezing* sprays into the air a large number of small droplets of water which contain the infective organism and these may be carried over a distance of several feet and inhaled by another person. The fresh discharges of the mouth and nose may also be transmitted by the handling of common objects eventually reaching the mouth or nasal passages of a well person. In this group of diseases the usual processes of isolating the sick, and controlling the carriers are fundamental procedures.

Contact Diseases.—The fourth or contact group of diseases includes maladies which vary widely in their nature, but have a point of similarity, in that they are spread by direct contact (touching) of the well person with the infected human or animal, as the case may be, or they are spread by a direct contact with infected material such as clothing or bedding.

Anthrax, glanders, and *foot and mouth disease* are transmitted to man from other animals or from animal products, like the hair, hides or flesh. Contact with the infected material allows the disease to enter through the skin or mucous membrane or less rarely through the alimentary or respiratory tract. *Actinomycosis,* a disease produced by a mould and commonly called "lumpy jaw" when it occurs in animals, is also occasionally transmitted to man by direct contact. In such a group of diseases the control of disease in animals is the fundamental sanitary procedure.

Other diseases in the contact group are transmitted directly from the sick to the well by the prompt transfer of the infective agent either directly or by the well person handling or using materials or articles which have just been in the possession of the infected individual. In this group we have the *venereal diseases,* (syphilis, gonorrhea, and soft chancre); we have also *trachoma,* a disease of the eyes or

conjunctiva in which the infection is often transmitted by use of the common towel. We have also *erysipelas*, a disease of the skin which makes its way to the victim through the abraded skin of the mucous membrane. We might also add *scabies* (itch), which goes from person to person when sufficiently close contact allows the itchmite to make its way to the body of the new host.

In some diseases of this group the infection is introduced into the body through actual rupture of the outer skin. *Tetanus* or lock-jaw is produced by a bacillus which although causing serious disease or death in man lives normally in the intestinal tract of animals without producing disease. This organism not only lives in the intestinal tract of animals, but is a normal inhabitant of the soil, and its mode of entrance into the body is with dirt which finds its way into the wound. This disease even in war is almost completely controlled by prompt attention to the cleanliness of wounds and the use of a specific antitetanic serum which prevents the disease from developing.

Rabies is likewise a wound disease. Here the organism of the disease is present in the saliva of the infected or rabid dog and when the individual is bitten by the dog the virus is introduced directly into the wound. Here then the control of the disease is obviously to be sought through the control of dogs or other animals which are subject to the infection.

The contact diseases are perhaps as widely different as those in any of the groups above mentioned, and each, of course, must be treated and prevented according to its own specific nature. On the whole the central problem of control lies in the proper isolation and care of the infected human beings or animals in order that they themselves and materials which they may have infected shall not come in contact with well people.

Summary.—The problem of the sanitarian in preventing the spread of communicable disease is obviously one which

demands detailed professional knowledge and administrative skill. The procedure for no two diseases is exactly the same and a complete knowledge of the disease in question is the only proper basis for undertaking its prevention. In general we have seen, however, that diseases may be divided on the basis of the nature or manner of spread into four groups. First, the alimentary diseases are those in which the infected organism is in the intestinal tract and for which the primary procedure for control lies in the supervision of food and water supplies and in the proper disposal of excreta. The group of insect-borne diseases in general may be best attacked by attacking the insect which carries the particular disease. The respiratory diseases are spread through droplet infection and attack the host through the respiratory tract. Here early diagnosis and complete isolation of the infected individuals are of fundamental importance. In the contact diseases the well must be kept from contact with infected material. In all cases a basic knowledge of the disease on the part of the general public and sufficient popular education to insure the development of sanitary living and hygienic habits will be of fundamental aid in disease prevention.

CHAPTER X

ESSENTIAL FACTS OF IMMUNITY

We have seen something of the nature of germ diseases and something of the relationship between these parasites and man. There are many other questions which come to one's mind. Why can certain bacteria grow in the human body but not in the body of lower animals? Why do the lower animals have certain diseases to which man is immune? Why do the parasites of certain diseases attack the same part of the body? Why does having had certain diseases make one immune to them thereafter? How does nature fight the disease? What is the explanation of the protection furnished by vaccination? How is immunity explained?

The presence of an immunity is easier to understand than the process by which it is secured. For the ordinary individual the fact is all important but the science of immunology is the foundation of the art of preventive medicine and a brief statement of the essential facts in this rapidly developing science has a place in any extended discussion of the subject of hygiene.

Immunity Defined.—Immunity is a common property of life which may be defined as the power of the organism to resist infection. It is opposite in meaning to the word susceptibility and both these words are relative terms. Immunity may be complete, or so weak as to be hardly appreciable. In many instances we use the term resistance as equivalent to immunity.

Another variable quantity, which is always related to the immunity of the patient, is the virulence of the disease-producing organism. By virulent we mean poisonous or deadly and we find that different strains of germs have varying abilities in their power of evil just as individuals have the varying powers of resistance.

We may illustrate immunity with an analogy from international experience. It is not very difficult for us to conceive of a nation thirsting for world power and opposed to the welfare of the great body of humanity outside that nation. The people of such a country may represent the germs of a disease and the great body of humanity, the person subject to the disease. The individuals of such a nation usually appear innocent enough and, like the germs of disease, quite similar to their harmless neighbors. There finally arises an opportunity for the invasion of other lands and these people make war upon the rest of the world just as the germs enter into a struggle with the human body. If they are successful the life of the invaded nations comes to an end; if they are not successful in their war they are eliminated from the territory which they have overrun and their armies are reduced in strength and vitality, for the time being, just as the virulence of influenza seems to be reduced after the first severe epidemic. But the other peoples of the world, if they are wise enough to realize the danger from this lust for world conquest, will set up barriers against the return of a world war and if these barriers are strong enough future recurrences may be avoided. These barriers, like the factors of immunity, are varied, numerous and complex. They may consist of a new army to combat the destructive forces of the enemy, of military barriers set up against the entrance of the foe or a general readiness of the peoples to respond immediately to a threat of a new attack. Likewise the human body when attacked by the germs of disease may create new defensive substances which remain in the blood, the tissues subject to microbial invasion may become more resistant to the particular organism or the whole bodily reaction may be more prompt and effective at a second attack.

Our knowledge of immunity has been gained from the observation of diseases and from experimental biology but not from chemistry. In other words, we are not yet able to state the chemical reactions in immunity and disease and we must

expand the science by a study of the reactions of experimental animals and the reactions of the immune substances which they produce.

We should recognize at the outset that the resistance of an individual to disease is determined by two factors, his general bodily health or vigor and the presence or absence of specific immune substances in the blood. These two factors are not of the same relative importance in all diseases. In cases of tuberculosis, pneumonia and colds or in cases of sepsis, bodily vigor is very important. In most of the contagious diseases, such as scarlet fever, smallpox, typhoid fever, and measles, however, general good health is of little importance in withstanding the infection and immunity can only be secured through the presence of immune substances in the body. It may be that the importance of bodily vigor in combating tuberculosis, colds and other respiratory diseases, is related to the important part played by the living cells (phagocytes). Although the diseases in this group are not numerous they are very important and we may do well to begin by enumerating some of the most important factors in destroying immunity through the reduction of bodily vigor.

NONSPECIFIC IMMUNITY

The things which most frequently break down the nonspecific immunity or general vitality are the following:

1. Fatigue.—Experimentally it has been found that white rats are more susceptible to anthrax after being worked in a revolving cage; and it has also been found that the defensive powers of dogs, rabbits and guinea pigs against typhoid are reduced by excessive exercise. It is hard to explain how fatigue produces these results unless we accept the suggestion that katabolic products of muscular activity are injurious to the cells, especially the white blood cells which, as we shall see later, play an important part in immunity. It is known that these products are acid and that some of the protective sub-

stances in the body (alexins and opsonins) act best in an alkaline medium.

2. **Exposure to Wet and Cold.**—Exposure to wet and cold reduces the power of resistance to disease, as has been demonstrated in the case of fowls which are naturally immune to anthrax but contract the disease after standing some time in cold water. We know that such exposure cools the blood and must therefore reduce the activity of the leukocytes. It may also reduce the production of defensive substances in the body. This relation to temperature would explain how muscular exercise reduces the danger of diseases under exposure to cold and wet by keeping up the body temperature. Sudden exposure to dampness and cold, especially if the individual had reduced the efficiency of the heat-regulating system of the body through improper clothing and poor ventilation, would produce a lowered resistance in this manner.

3. **Drugs.**—Excesses in the use of drugs and alcohol are well known and important in increasing the susceptibility to tuberculosis. The factors involved here may be the lowering of the temperature, the destruction of delicate defensive substances in the body and the inhibition of leukocyte activity.

4. **Malnutrition.**—Insufficient or unsuitable food accelerates tuberculosis. This may be explained by the fact that digestion increases leukocytosis. Moreover, infection is more likely to pass through an empty stomach than one where acid digestion is rapidly taking place. Research upon diets deficient in vitamins indicates that susceptibility to certain infections increases when these substances are lacking.

5. **Physical Defects.**—Bacteria which are growing at the roots of teeth or in chronically inflamed tonsils are producing poisons which continually tax the protective powers of the body and therefore make it easier for other infective organisms to enter and produce disease. Moreover a dirty mouth, already harboring a variety of bacteria, is a better culture place for disease germs than is a clean mouth. Enlarged tonsils and adenoids reduce the body vigor by their injurious effect upon breathing and nutrition.

SPECIFIC IMMUNITY

Specific immunity exists by virtue of certain substances (immune bodies or antibodies) present in the blood, which prevent or retard the development of the disease in question. It may be natural or acquired, general or local. Acquired immunity may be active or passive.

Natural Immunity.—Certain species of animals are immune to the diseases which affect other species. For example, the lower animals are immune to many of the communicable diseases of man, such as cholera, typhoid fever, mumps, measles, scarlet fever, yellow fever, malaria, leprosy, etc. Man is immune to many of the diseases which attack lower animals. There are certain germs, however, which attack many species of widely different genera. Examples of this group include the organisms of tetanus, malignant edema, anthrax, pus formation, glanders, plague, rabies, Malta fever, foot-and-mouth disease, milk sickness, ringworm, and paratyphoid fever.

Local Immunity.—Many tissues of the body appear to be immune to diseases which do serious damage to other tissues. For example, diphtheria does not often extend from the throat down the esophagus. There may even be a difference in the susceptibility of the same tissue at different periods of life. In general, tissues which are well flushed with blood are relatively immune. Prompt local reaction frequently saves the more remote tissues of the body by holding back the organisms and in general this is a good indication of immunity.

Acquired Immunity.—Acquired immunity is specific for particular diseases and is not inherited. It may be secured by having the disease or artificially induced by the injection of a virus or a vaccine. By *virus* we mean the living organism of infection and by a *bacterial vaccine* the killed organism of the infection. It is obvious that the virus must be reduced in virulence or introduced in very small quantities while the vaccine is less severe and more likely to produce a local reaction followed by a brief general reaction. Sometimes *sen-*

sitized vaccines are produced by mixing the bacteria with the specific antibodies from the blood serum of an animal which has been rendered immune. *Polyvalent vaccines* are made up from several strains of the same organism. *Mixed vaccines* containing the dead bacilli of two or more diseases like typhoid, paratyphoid and cholera are sometimes used. Immunity acquired through the use of vaccines usually lasts from two to five years.

Active and Passive Immunity.—The above description refers to active immunity. In other cases the immunity may be passive. In diphtheria the horse from which antitoxin is secured is rendered immune to the disease by the injection of increasing doses of diphtheria toxin and his immunity is active. The patient may be made temporarily immune by the injection of immune substances from the blood serum of the horse. This immunity is passive or transferred and is of brief duration. (Diphtheria antitoxin is ordinarily used in the treatment of the disease, but it is sometimes used to confer a temporary, passive immunity upon a susceptible person who is known to have been infected with the diphtheria bacillus.)

Carriers.—Usually after a disease the body rids itself entirely of the germs. Occasionally, however, this does not happen and a condition of mutual tolerance is set up. This "immunity without disinfection" is a condition in which the patient continues to be a *carrier* of the germs. The reaction between the patient and the infective organism is not serious. They have acquired the ability of tolerating each other, and the reaction by each has apparently become milder. Carriers are found in diphtheria, typhoid, cholera, epidemic cerebrospinal meningitis, influenza and in certain protozoan diseases like malaria. Many epidemics have been traced to such carriers. There is always a possibility of a spread of the disease in this fashion and in some instances the lowered vitality of the individual may result in a relapse of his own case.

Disease Reactions.—Just as different agricultural plants grow best in different soils, select somewhat different foods, and produce different products, so the germs of disease vary in the part of the body which they attack and differ in their life processes and in the effects they produce upon the individual. The actions and reactions between the various microbes and man are numerous and complex. This is not the place for an extended discussion of them; but they have such an important bearing upon our comprehension of disease and the terms are so rapidly finding a place in our everyday vocabulary that a brief description of the terminology and phenomena may be found useful to the college or university student. We shall, therefore, consider briefly the nature of the struggle waged during the course of an infectious disease.

Toxins.—There are two types of bacterial poisons which produce disease, exotoxins and endotoxins. The true toxin (exotoxin) is defined by Rosenau as "a specific poison elaborated by bacterial metabolism; it is soluble in water; poisonous in minute amounts; reproduces the essential symptoms and lesions of the disease; acts only after a period of incubation; and produces antibodies, namely, antitoxin." Such toxins are complex chemical substances probably belonging to the higher proteins. They are thermolabile and unstable. Three such substances are well known, the toxins produced in diphtheria, tetanus, and botulism. Other bacteria, such as dysentery, pyocyaneus and cholera produce soluble toxic substances which do not, however, have all the above named characteristics.

We should add that many bacteria produce poisonous substances of another type such as ferments, ptomains, acids, alkalis, nitrites and hydrogen sulphid. The bacilli of tuberculosis and glanders form soluble toxic substances which are specific but (in small quantities) harmless in a normal animal, being poisonous only to an animal suffering with the specific disease.

There are also toxins from the higher plants such as ricin from the castor bean and abrin from the jequirity bean. These so-called phytotoxins comply with the above definition of a true toxin in most respects. The venoms produced by wasps, scorpions, spiders, and snakes are very similar substances.

In the case of the true toxin it is impossible to say whether it is a secretion or an excretion or the result of the action of the bacteria upon the medium. There are four important characteristics of these toxins. They are destroyed by boiling or by heating at 63 degrees C. for a short time. They are extremely poisonous in small quantities (0.000,000,05 of a gram of tetanus toxin is sufficient to kill a mouse). They produce their effect after an incubation period and have a specific combining affinity for particular cells of the body.

Endotoxins.—Certain bacteria contain internal poisons which may be liberated when the bacterial cells die. It is possible to obtain endotoxins by grinding the cells of the dysentery bacillus and the cholera vibrio. We should not conclude, however, that endotoxins are similar in their action and composition to true or *exotoxins*. It may be moreover that the split protein products of the bacteria themselves act as poisons to the body cells.

Reactive Phenomena.—The body has been found to react in definite ways to particular diseases and our knowledge of the basis of immunity rests upon the study of these phenomena which include (1) phagocytosis, (2) anaphylaxis, and (3) the production of specific substances like antitoxins, opsonins, lysins, precipitins, and agglutinins.

1. Phagocytosis. The important work of Metchnikoff in the study of immunity showed that certain bacteria are devoured and digested in great numbers by the cells of the body. Cells which accomplish this task are of two types: the motile cells (white blood cells) and the fixed cells of the connective tissue and endothelium. Metchnikoff believed this phenome-

non of phagocytosis to be the principal bodily activity in combating disease and producing immunity.

These cells are susceptible to chemotactic influences and it is conceivable that the attack of a disease might so accelerate their activity that at the inception of a second infection the invading bacteria might be devoured before the disease could be produced. Phagocytosis however is not a complete and adequate explanation for immunity unless it is believed that the phagocytic cells produce special immune bodies—to be considered later.

Opsonins.—Phagocytosis has beeen found to take place only in the presence of certain substances which prepare the bacteria for phagocytic digestion. These substances, which are called opsonins, are normally present but may be increased by the injection of bacteria or a specific antigen. They combine with the bacteria and phagocytosis does not take place without them. The opsonic index which is used in vaccine therapy is the measure of these substances as determined by the "avidity" with which phagocytic cells devour the bacteria.

2. Anaphylaxis.—Anaphylaxis or hypersusceptibility is a condition of the body in which it is unusually susceptible to foreign proteins. This is a specific reaction which may be developed against certain bacteria or other protein substances. It may be congenital or acquired, local or general

An example of anaphylaxis as produced by an ordinarily harmless substance is secured by the injection of horse serum into a guinea pig. If the second injection of serum is separated from the first by an interval of eight to fourteen days it produces what is known as acute anaphylactic shock. The guinea pig becomes restless, manifests difficulty in breathing, is generally agitated and discharges both urine and feces. There may soon follow complete paralysis, the arrest of breathing, and death. The guinea pig is apparently much more susceptible to this reaction than any other animal. The explanation of this fact and the phenomenon itself is fur-

nished by Schultz who showed that serum anaphylaxis produces the hypersensitization of smooth muscle tissue which contracts during shock with the fatal results, in the case of the guinea pig, because the mucosal layer of its secondary bronchi is thrown into folds by the contraction of this muscle and breathing is inhibited. This reaction is strictly specific.

By examples of other types of anaphylaxis it may be seen how this increased sensitivity of the tissue to particular germs may produce a very prompt reaction which may be connected with acquired immunity. In the second vaccination for smallpox the incubation period is much shorter and in the prompt "take" the reaction is less severe. It appears in this case that immunity is not complete but the protection is dependent upon anaphylaxis. In other diseases this prompt reaction may prevent the development of the clinical symptoms.

In guinea pigs such a sensitization may be produced by feeding them meat or serum and the mother guinea pig may transmit a hypersensibility to the toxic action of horse serum to her young. We may raise the question as to whether these facts may not explain why symptoms like those in anaphylactic shock sometimes follow the eating of fish and other articles of diet and whether this phenomenon explains a possible inherited susceptibility to tuberculosis.

The serum sickness, which often takes place from 12 to 14 days after the injection of antitoxic sera and shows symptoms of fever, itching and pain at the point of injection and a general urticaria, may be the anaphylactic reaction from these substances still remaining in the body at the end of the incubation period. The substances which produce serum sickness however are the proteins of the horse serum and not the antitoxin itself.

In considering other examples of anaphylaxis it is to be noted that in most febrile diseases there is a ten to fourteen day incubation period before the general bodily reaction marks the beginning of the active period of disease. Diphtheria or other diseases where soluble toxins are produced obvi-

ously do not belong in this class. Tuberculin (a glycerine extract from tubercule bacilli) is not poisonous to a healthy individual but produces a definite reaction in a tuberculous individual because he has become anaphylactic to the disease. This test for hypersusceptibility, therefore, may be used in detecting the disease. It may also be seen that the hypersusceptibility of the tissue produces a prompt reaction which helps to encapsulate the organisms.

It has long been known that in many people fish, tomatoes and cheese are likely to produce an urticarial rash; eggs may produce asthmatic symptoms; and cereals, pork and milk may produce erythemas. These cases and many cases of eczema may be due to anaphylactic reactions to the special proteins.

Anaphylaxis in hay fever is the hypersusceptibility of the mucous membrane of the respiratory tract to the pollen of ragweed, golden rod and other plants. Dust emanations from horses or other animals or hyperacidity of the gastric juice may produce similar conditions. Puerperal eclampsia, the onset of labor, and the crisis in pneumonia have been in part explained by the phenomena of anaphylaxis.

3. Specific Substances.—*Antitoxins.*—Antitoxins are substances formed in an animal by the stimulation of specific toxins. They are capable of neutralizing the corresponding toxins. They are substances of complex chemical composition, more stable than toxins although destroyed by heat, acids and many other chemicals. These substances appear in the blood and in all the fluids and excretions of the immune animals. When they are introduced into the body, as in the use of diphtheria antitoxin from the horse, they disappear rather quickly, uniting with the toxin or with the body cells but mainly finding exit through the urine, bile and saliva in the form of antitoxin. Passive immunity therefore is transient and lasts usually from ten to fourteen days while active immunity is of much longer duration. Antitoxins are not always

Note: The instructor may prefer to omit a consideration of specific substances and theories of immunity.

produced as a reaction to bacterial toxins even in susceptible animals. A guinea pig which is highly susceptible to diphtheria will not produce any antitoxin.

It can be shown that there is a direct union between antitoxin and toxin by mixing the two in a test tube and then injecting the mixture into a susceptible animal. This injection produces no observable or injurious result. After the toxin has once been united with the body cells however it cannot be dislodged by an antitoxin. It may thus be seen why moderate amounts of diphtheria antitoxin in the earlier stages of the disease are more efficacious than large doses administered at a later period. Antitoxin may be present in the blood before infection takes place.

Agglutinins.—Widal showed that very dilute mixtures of the blood serum of a typhoid patient will cause the typhoid bacilli to agglutinate, that is, to lose their motility and gather in little clumps. These small groups may be seen under the microscope or as flakes in a test tube suspension. It was later found that agglutinating substances may be produced in the blood by injecting dead bacteria into the body, as in typhoid vaccination.

Agglutination does not harm the bacteria by rendering them motionless. They may again multiply and grow vigorously. The so-called germicidal property of freshly drawn milk is probably mainly a phenomenon of agglutination, since the bacteria are clumped together and only one colony for each clump of organisms is developed on the agar plate.

Agglutinins are not absolutely specific since, if they are used in large quantities, closely allied species of bacteria may also be agglutinated. They are however, quantitatively specific, since the corresponding organisms will be agglutinated by a greater dilution. Agglutination may also be produced for red blood corpuscles and protozoa. The part which these substances play in immunity is not yet clear.

Precipitins.—In 1897 Kraus showed that it is possible to produce another type of immune body in the blood serum of

an animal by the injection of bacteria or albuminous substances. When the clear serum of an immunized animal was added to the clear antigen the resulting fluid became opaque from the formation of a precipitate which soon settled to the bottom of the test tube. This discovery was made by adding some typhoid serum to a filtered culture of typhoid bacilli. Certain other organisms like cholera and plague produce the same phenomenon but not all bacteria do this and the diphtheria bacillus is the important example of the latter class. This precipitation is similar to the agglutination of bacteria and is a reaction of protein molecules which, as we know, are not true solutions but colloidal suspensions. The relation of these substances to immunity is not clear but we may see how it may be possible for them to throw down poisons from solution and make them inert.

Lysins.—In 1896 Dr. Pfeiffer observed that when living cholera vibrio were injected into the peritoneal cavity of a guinea pig which had been previously immunized against cholera they lost their power of motion, became grouped together in clumps and were finally completely dissolved. This reaction which is specific for special diseases is known as Pfeiffer's phenomenon, and the substances which have the power of disintegrating or dissolving cells or other organized substances introduced into the body are called lysins. Those which disintegrate bacteria are called bacteriolysins, those which dissolve the red blood corpuscles of other animals are called hemolysins, and those which dissolve the cells of glandular tissues are called cytolysins. The normal bacteriolytic properties of the blood are thought to be due almost entirely to a similar nonspecific substance which dissolves the various bacterial cells. It is this power which enables the blood to resist decomposition longer than other animal fluids.

That the complete explanation of immunity is not furnished by the lysins is shown by the fact that animals may be susceptible to disease although the blood possesses bactericidal properties. In anthrax the rabbit is very susceptible although

the blood serum is highly bactericidal, while the dog is very resistant although the blood is slightly bactericidal.

Bacteriolysins are distinct from antitoxins and agglutinins. The three substances may be distinguished from one another by proper tests even when they exist together. The lysin is composed of two substances, the immune body which prepares or sensitizes the bacteria and the complement which dissolves the bacteria. The *complement* appears to be formed by the breaking down of leukocytes and is present in normal blood. Although present in the blood it is absent in the aqueous humor of the eye because the latter lacks leukocytes. It is the immune body or *amboceptor* which is specific for particular diseases and which is increased as immunity is built up.

Hemolysis or the laking of blood is the dissolving of hemoglobin from the red blood corpuscles. There are two types of hemolysins: (1) the nonspecific such as distilled water, acids, alkalis and bacterial, plant and animal toxins, and (2) the specific hemolysins which are obtained by treating or immunizing the animal with the red blood corpuscles of another species of animal. Hemolysins of the latter type are similar to bacteriolysins.

It has been stated above that the amboceptor is specific while the complement is nonspecific. The complement fixation test used in the diagnosis of syphilis, gonorrhea, glanders, pertussis, meningitis and other infections is based on this principle.

THEORIES OF IMMUNITY

It should now be apparent that infectious diseases and bodily reactions to these diseases are widely different and that no simple theory of immunity can be satisfactory. It is, therefore, only with historical interest that we regard the early theories of Pasteur and Chauveau.

Exhaustion Theory.—In 1888 Pasteur suggested his exhaustion theory which held that immunity was produced because all the food substances were used up. The one fact that

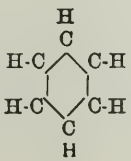
bacteria may grow in the dead tissues of immune animals shows that, during the life of the animal, their growth is inhibited by specific substances and not by lack of food.

The Retention Theory.—The retention theory of Chauveau maintained that bacterial growth was inhibited in disease by the retention of the products of bacterial metabolism. It is not difficult to demonstrate the fallacy of this view.

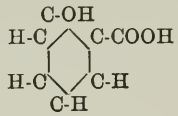
Phagocytic Theory.—The work of Metchnikoff in demonstrating the activity of phagocytosis suggested a possible mechanism of immunity. It could be demonstrated that the phagocytic powers of an animal increased directly with its immunity and Metchnikoff asserted that it was the increased activity of the white blood cells which produced immunity. We have seen in the development of opsonins the influence of the body fluids upon phagocytosis.

These views were opposed by Ehrlich and other investigators who believed immunity to be due mainly to substances produced in the body and set free in the body fluids. From their point of view phagocytosis was merely the process of getting rid of bacteria after they had been acted upon by the immune-body substances. Metchnikoff realized the existence of these substances in the body fluids but he believed them to be derived from the leukocytes. The question is by no means settled and there is much evidence to support the great importance of phagocytes in bacterial immunity.

Side Chain Theory.—Every student of organic chemistry is familiar with the term side chain as applied to the atomic groups attached to the benzol ring. The graphic formula for benzene is:



This central structure is possessed by a large number of compounds. For example salicylic acid has the following formula:



The OH and COOH groups are side chains through which other substances and new atomic groups may enter into relationship with the benzol ring.

The side chain theory of immunity, which was developed by Ehrlich, is a theory of chemical side chains which are attached —not to a simple ring as in the benzol group—but to a central atom group of the large and complex proteins which make up cell structures.

In 1885 Ehrlich had stated his belief that the cells of the body take on nutrition through the reaction of side chains, from the central protein molecules, with the various nutritive substances in the circulating blood. It seemed reasonable to him, therefore, that toxin might exert its injurious influence upon the cells of the body by combining with certain chains of the cell protein. Certain of these side chains might have a specific affinity for a particular poison. When this union had taken place, however, the side chains would be destroyed.

Now it is characteristic of nature to regenerate parts of tissues which are lost and such regenerative processes are almost always carried to excess. A good example of this is seen in the excessive production of bony substance after a fracture. It seemed reasonable that, in this case, nature might produce an excessive number of side chains or receptors under the continued stimulation and if this were done some of them would be thrown off into the blood where they would be free to circulate and unite with the poison before it could reach the sensitive cells. With such a substance (antitoxin) in the blood a new infection would not produce the clinical symptoms of disease and the person would be immune from the disease

in question. This type of immunity is spoken of as *immunity of the first order* and is illustrated in the explanatory diagram.

We have seen that the body may possess different kinds of immune reactions as exemplified by the power of blood serum to agglutinate and precipitate such disease germs as those of typhoid fever. The bacterial substance which injures the human body in this case is not a soluble substance, but a complex molecule of the bacterial protoplasm. It seemed to Ehrlich that the immune bodies in this type of reaction must be more complex than the receptors described above. Side chains which are capable of handling these albuminous substances he conceived to have not only a combining (haptophore) group, for anchoring the substance to the body cells, but also a ferment (or zymophore) group which could break down the complex molecule after it was anchored. The agglutinating power of the blood of an immune individual he conceived to be due to the presence of these receptors of the second order which would be thrown off into the blood under continued stimulation, like the antitoxin type of receptor. This *immunity of the second order* is also illustrated diagrammatically.

The process of bacteriolysis which has an important bearing on immunity is of a different nature than the two phenomena just described. Students of this phenomenon found that the normal blood of animals has the power of killing certain disease germs to a limited extent, and that the blood of specifically immune animals has the power of killing and dissolving the particular organism for which the animal is immune to a great degree. It was also learned that the blood of an immune animal loses this power upon being heated to 56°C. but that the power is regained by the addition of a little normal serum from a nonimmune animal. Reasoning from these data Ehrlich assumed and later proved to his own satisfaction that, in this type of immunity, there is a nonspecific dissolving substance (complement) in the normal blood which is able to act upon the bacteria only in the presence of and by combining

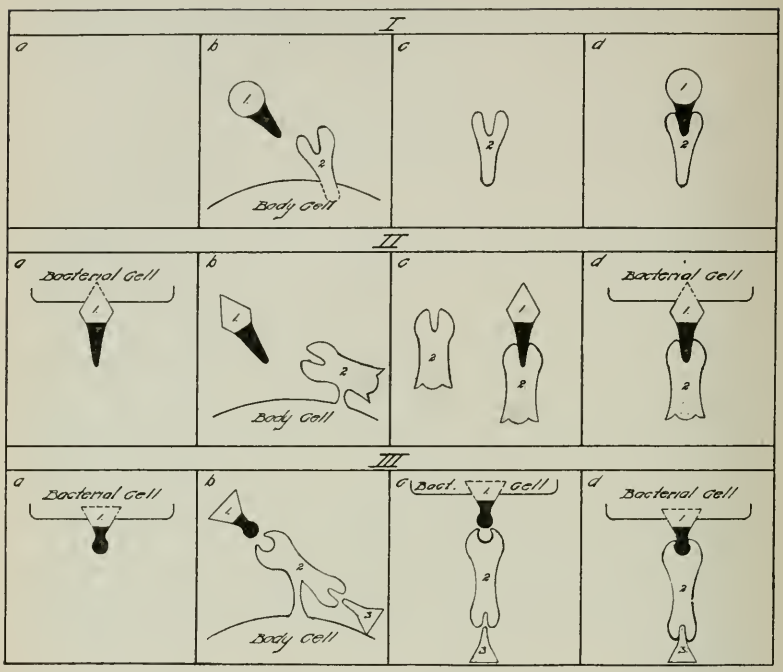


Fig. 34.—Diagram illustrating the three orders of immunity as described in Ehrlich's Side Chain Theory of Immunity.

I. *Immunity of the first order.* 1. Inciting substance (toxin). 2. Immune substance (antitoxin). (b) Shows antitoxin which has been absorbed into the blood stream from the diphtheritic throat. The toxin molecule is seen approaching the side chain. (c) By the excessive production of side chains antitoxin is thrown off into the blood. (d) The antitoxin unites with the toxin in the blood, preventing the latter from attaching the living cells.

II. *Immunity of the second order.* 1. Inciting substance antiagglutinin, antiprecipitin, etc.). 2. Immune substance (agglutinin, precipitin etc.). The immune substance in this case shows a haptophore group (joining end) and a zymophore group (portion containing an enzyme). (a) Bacterial cell with inciting substance in the blood (b) inciting substance about to combine with side chain of body cell. (c) Free antibody in the blood and combination of inciting substance and antibody (precipitin reaction). (d) Antibody combining with inciting substance in the bacterial cell (agglutination).

III. *Immunity of the third order.* 1. Inciting substance (anti-immune body). 2. Specific immune body having a cytophile group which combines with the inciting substance and a complementophile group which combines with the complement. 3. Complement of nonspecific immune body free in the blood. (a) Bacterial cell with inciting substance. (b) Inciting substance about to unite with side chain (amboceptor). (c) Immune bodies and bacterial cell free in the blood. (d) Union of three bodies in bacteriolysis.

with specific side chains produced by the cell proteins in a manner similar to the way the above mentioned receptors are produced. The side chain of the body cell in this third type of immunity has two receptive parts. When such side chains or receptors are thrown out into the blood they unite with both the reactive substance of the germ cell and with the complement, which, acting through these receptors, is able to dissolve the bacterial substances. A similar reaction takes place when the body is immunized to foreign blood or other cells. Part three of the diagram shows the nature of this *third order of immunity.*

In all of the above-mentioned orders the immunizing substances are supposed to be produced by the body cells and they appear in the blood by the excessive regeneration of those first destroyed by the bacterial poison. The immune substances of the first order, when they are free in the blood, are spoken of as antitoxins, those of the second order are precipitins or agglutinins, those of the third order are called amboceptors.

Vaughan has shown (*Protein Split Products,* Lea and Febiger, 1913) that split protein products from most proteins will produce a fever reaction if injected into the body systematically. Such substances are produced by almost all bacteria. It is a question whether the fever reaction produced by such organisms as the typhoid bacillus may not be due to these split proteins by a sort of consecutive anaphylactic poisoning rather than by specific endotoxins.

The Bacteriophage.—There has been advanced recently the theory of immunity by the bacteriophage. F. d'Herelle,[1] in his book, *The Bacteriophage and Its Rôle in Immunity,* describes the action of an ultramicrobial organism parasitic upon bacteria. His attention was first called to the possibilities of such a phenomenon when studying a patient under treatment for dysentery in the Pasteur Hospital.

[1]d'Herelle: The Bacteriophage. English translation by Smith, Williams and Wilkins Co., Baltimore, 1922.

Every day an examination of the feces from the patient was made by the inoculation of bouillon with some of the fecal material. After incubation at 37° C. overnight the growth was filtered through a Chamberland filter. To a second tube of broth, previously inoculated with a culture of the Shiga bacillus, twelve drops of the above filtrate were added and the culture so treated was returned to the incubator. Throughout the period of infection all the tubes, prepared each day in the same manner, yielded normal growths of the dysentery bacillus.

One day, examination of the tube prepared the day before showed no growth, and investigation showed that the patient presented symptoms indicative of marked improvement. Definite convalescence rapidly followed. The bouillon tubes inoculated daily with filtrate and Shiga bacillus remained sterile. One of these supposedly sterile tubes was then heavily infected with the Shiga bacillus producing a distinct turbidity, but after incubation for 12 hours it was again clear. The excreta from which the filtrates were prepared contained, then, a principle which dissolved the dysentery organisms.

When a drop of the lysed culture was added to a young bouillon culture of Shiga bacilli this culture in turn became dissolved. In the same way, several successive passages were accomplished, the potency of the lysis increasing at each transfer. From this it was evident that the lytic principle derived from the excreta was capable of cultivation in series, was possibly then a living organism.

Further experiment showed d'Herelle that this lytic principle or bacteriophage is a particle which proliferates at the expense of bacteria and as a result is capable of assimilation. It is indefinitely cultivable in series *in vitro* in the form of a filterable substance. M. d'Herelle tells us that the bacteriophage is not specific in its action but may acquire virulence from any organism and lists some 19 organisms, including the four strains of the dysentery bacillus, B.

coli, B. typhosus, and paratyphosus A and B, B. diphtheriae, staphylococcus and others.

Not only were dysentery, barbone, and avian typhosis cured by the bacteriophage, but also in many carefully detailed experiments definite immunity of susceptibles was demonstrated.

To summarize, d'Herelle gives the rôle of the bacteriophage in immunity, as "the defense of the susceptible individual in the course of natural disease. Parasitic of bacteria, the bacteriophage intervenes directly to destroy the pathogenic bacteria; secreting lysins endowed with powerful opsonic action, it renders possible the education of the phagocyte and aids in the establishment of organic bacterial immunity; dissolving the bacterial cells, it transforms the bacterial substance into such a chemical and physical state that it can stimulate the cells of the body which produce the antitoxic antibodies, it aids thus in the establishment of organic antitoxic immunity."

CHAPTER XI

THREE GREAT PLAGUES

Diseases which are spread because of the existence of unsanitary conditions have been rapidly brought under control, but the diseases which are spread largely by personal contact have not been correspondingly reduced. Perhaps no illustration is better than the communicable disease history of the army during the four last wars. We may show graphically how the number of disease deaths have declined in relation to the number of battle deaths. This is a remarkable achievement but it is chiefly an achievement of sanitation. Intestinal and insect-borne fevers have been almost eliminated. On the other hand the respiratory disease rate remains very high. Pneumonia caused 13 per cent of the deaths of the Civil War and but 3 per cent of the deaths in the Spanish War. But in the World War it caused 85 per cent of all deaths from disease, having a death rate of over 9 per thousand. If the respiratory diseases had been eliminated from our army in the World War the army disease death rate would have been practically that of the civilian population.

In civil life as well as in warfare the diseases transmitted by mouth and nose secretions present a great unsolved problem. It is not our purpose to consider here the detailed pathology or the administrative methods of control for the various communicable diseases. *Appendix A* contains a brief but comprehensive summary of the public health facts regarding them. There are, however, three diseases which are of paramount importance to society. We may refer to these diseases in popular language as the Great Red Plague, the Great White Plague and the Great Pandemic. They are syphilis, tuberculosis, and common cold. Progress can be made against these scourges only by a broad and almost universal knowledge of their nature, their seriousness, transmission

and the methods by which they may be combated. It seems worth while, therefore, for us to give them more detailed consideration.

TUBERCULOSIS

Prevalence.—Descriptions of tuberculosis may be found in the earliest medical writings. It has always been an impor-

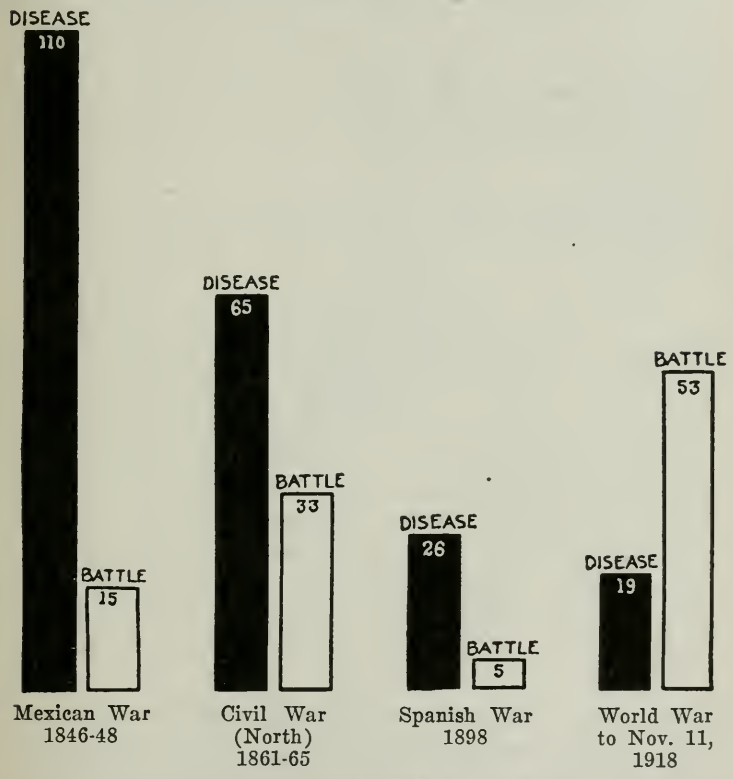


Fig. 35.—Comparative figures showing the number of disease and battle deaths each year per thousand troops in the wars of the United States. (United States Army figures.)

tant disease. It is the most wide spread of all infections and one of the most important causes of death. Tuberculosis is a disease of young people and carries away its victims in

the prime of life at the height of their earning and productive capacities. We know its cause and the most important modes of transmission. Gradually it is being brought under control.

It has been estimated that the number of cases of tuberculosis in any community is approximately 10 times the number of annual deaths from the disease. That is, if a town has

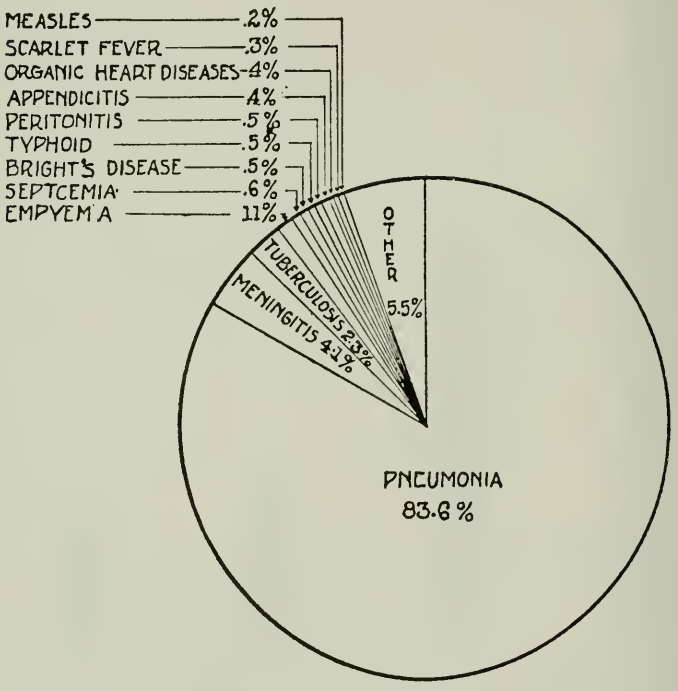


Fig. 36.—The relative proportion of army deaths caused by the principal diseases in the war with Germany. (United States Army figures.)

50 deaths from tuberculosis yearly it probably has 500 active cases. This figure has been confirmed by careful tuberculosis experiments conducted by the Metropolitan Life Insurance Company in the city of Framingham, Massachusetts. When this work was started there were three known cases of

tuberculosis per annual death in the city. Large blocks of the population including thousands of people have received physical examinations during this health experiment and a tuberculosis expert was provided who gave free consultation to the practicing physicians. The figures obtained from the investigation showed 9 cases of active tuberculosis and 11 cases of arrested tuberculosis per annual death.

The Difficulties.—Why is it that the Great White Plague continues to take its annual toll in lives of our people while typhoid is being rapidly banished from our country? The following are some of the difficulties in combating tuberculosis:

(1) The disease is transmitted by contact and therefore has not the same direct relation to sanitation as has typhoid fever.

(2) Notwithstanding earnest effort there seems as yet no way of producing an artificial immunity by the use of vaccine or serum treatment. The recent Calmette-Guerin vaccine is still on trial. The reaction of the body to tuberculosis is cellular and not antitoxic. Instead of producing a chemical substance to combat the organism the body walls off the tubercle bacilli by the white blood cells and encapsulates them by the cells of the connective tissues. To be sure, the body becomes sensitized or anaphylactic from the first infection so that it may react more promptly, but since the reaction depends upon cell activity the bodily resistance depends upon the vitality of the individual and not upon a chemical substance.

(3) Bodily vigor which makes it possible to resist tubercular infection is impossible of universal attainment. It is very simple to say that fresh air, nourishing food, and sufficient sleep, will prevent or cure incipient tuberculosis but these very simple things are just what many people are unable to secure. Under the economic basis of society it is not possible for everyone to have healthy work, sufficient recreation in the open air, and a suitable diet.

(4) The disease is so benign and its onset so gradual that society is not aroused against it. A tuberculosis patient is often cheerful up to the very day of his death and there is nothing startling or terrible about the first stages of the disease. If tuberculosis were accompanied by a high fever and a disagreeable rash, as is smallpox, then rapid progress would be made in its elimination; but as it is, we somehow conclude that because it is common it is not dangerous, in spite of the fact that as many as 1 out of 12 of our acquaintances may die with this preventable disease.

Transmission of Tuberculosis.—It is to be remembered that there are two strains of organisms which produce this disease, the human and the bovine, and that there are many types of the disease, although phthisis or tuberculosis of the lungs is the most common form. Many other parts of the body are attacked including the bones, the meninges and the glands.

Glandular infections among children are very common and a large percentage of such infections are with the bovine strain. It has been stated that from one-fourth to one-third of the tuberculosis in children under five years of age is caused by the bovine type of bacillus which is probably ingested with cow's milk. Recent hospital records show the bovine bacillus to be the cause of 80 per cent of the glandular cases in children under 4 years of age and the cause in 100 per cent of such cases in children under one year of age. Records from a large number of cervical gland operations in children show that 65 per cent of gland infections were tuberculous and in 90 per cent of these the organism was the bovine type. Infection is therefore possible both from man and from animals and may be acquired both by inhalation and ingestion.

The chief source of infection from man is the sputum and it was formerly thought that the organism was most commonly acquired by being breathed into the lungs in droplets sprayed into the air by the cough of the tuberculous patient or in the

form of dust. This type of infection does take place. Cornet was able to infect 47 out of 48 guinea pigs exposed to the dust produced by sweeping a carpet which had been purposely infected with tuberculous sputum but this was an unusual condition and the dose of the infection was great. Moreover the continual breathing of dust irritates the lungs and makes it easier for the bacillus to gain a foothold. But although infection by inhalation does occur we have probably overestimated the importance of this method in the past.

We have recently come to regard more seriously the probability of infection through ingestion. The opportunities for infection in this manner are countless and it has been shown that the organism may make its way from the throat and tonsils to the glands of the neck and from the small intestines to the abdominal glands, to the lungs and other parts of the body. No doubt the presence of decayed teeth and infected tonsils makes it easier for the bacilli to multiply in the body by providing acceptable lodgings in the mouth and throat and by reducing bodily resistance.

We must accordingly recognize the danger of tuberculosis infections from contact in any of the various ways by which the infectious material from a tuberculous patient may reach our mouths. It may be that we handle infected material and then carry the fingers to the mouth or it may be that the infection is carried by milk, flies, cups, handkerchiefs, or other articles. This danger should make us more careful of food sanitation.

The number of bacteria taken into the body is important as it has been shown that men and experimental animals can resist a limited amount of infection. In fact investigators assert that almost every individual who has lived to the age of 25 or 30 years will show tubercular lesions at autopsy, although they may never have developed clinical symptoms of the disease. It seems therefore that everyone must receive tubercle bacilli. The question of whether we have tuberculosis or not depends upon the size of the dose and our degree

of natural immunity, which in this case is directly related to general health.

Tuberculosis is not hereditary although it is possible that some predisposition to it may be inherited. Of course if the child is taken care of by a tuberculous mother there is great opportunity for early infection.

The disease may indeed be spread through contaminated water supplies. Sputum which has not been disinfected frequently finds its way into the sewer and the feces themselves contain tubercle bacilli. These organisms are enclosed in a little fatty sheath and are therefore more resistant to cold water than many other organisms and it seems reasonable to believe that they may be present in a polluted water supply, especially since the vital statistics of various cities have shown a reduced amount of tuberculosis when the water supplies were improved.

Prevention and Control.—We have in our hands many weapons for combating the disease which we are not always using to the best advantage. Some of these may here be described.

1. *Education.*—In order that our campaign may succeed the people must understand the facts and the seriousness of the disease. Fortunately the message is a hopeful one because tuberculosis is curable. The public should know this but it should also know that it is transmissible. Many infections could be avoided by better personal prophylaxis if people would insist upon good ventilation, refuse to use common drinking cups or unpasteurized milk from cattle which are not tuberculin tested and if they would avoid intimate associations with cases of tuberculosis. Much could be done also by securing a desire for wholesome diet and by removing mechanical obstructions to breathing and other predisposing factors.

2. *Segregation.*—Much can be gained by separating the tuberculous patient from uninfected individuals. Hospitals should be provided for the advanced cases and sanatoria

should be available for the incipient cases. There is a practical difficulty here, for hospitals and sanatoria are expensive and it is not always possible to persuade the individual most needing the treatment to accept it. We have been particularly lacking in sanatoria where the middle classes of society could receive treatment at a reasonably low cost. The legal power to forcibly remove, isolate, restrain and keep under treatment the *irresponsible* and *incorrigible* consumptive is needed for the welfare of the community.

3. *Home Treatment.*—Even if enough sanatoria could be provided there are often disadvantages in removing a patient from his home and it is fortunate that so much can be done by home treatment if it is properly carried out. Dispensaries should be provided in large communities for the diagnosis, treatment and instruction of the consumptive. If this phase of the work is properly conducted any case may receive prompt and early diagnosis and may be taught how to avoid infecting other people. Something may be done to secure better housing conditions, a more suitable type of work and an improvement of diet. If the patient will honestly, intelligently, and conscientiously obey instructions he may have every hope of improving his condition in his own home, provided the disease is not too far advanced, and he will probably do better in mind and body if his home is not broken up. If the patient is unintelligent or incorrigible there is little hope for his recovery under any consideration and society must safeguard the health of the people who would be brought in contact with him and endangered by his carelessness.

4. *Tuberculosis Societies.*—The National, State and Local Societies for the Prevention of Tuberculosis are important factors in combating the spread of the disease. What is everybody's business is nobody's business and it is altogether too easy for the governmental agencies to neglect obviously needed activities for safeguarding the health of its citizens. Often the health official would like to do more but careless and un-

informed public sentiment will not support him. Fortunate is the community which has a group of interested citizens who can organize the necessary campaign for tuberculosis control.

One of the most important recent activities of tuberculosis associations is the work for the detection and treatment of child type tuberculosis. Children who are below standard in health are given a careful examination; and, if there are

Fig. 37.—An inexpensive and easily constructed outdoor sleeping porch.

indications of the disease, they are sent to a preventorium where they learn a program of healthy living while their vitality is being built up and the infection walled off in the tissues of the lung. An important step in the physical examination is the use of the x-ray to determine the presence of infection in the lungs or in the lymph nodes of the chest.

SYPHILIS

Venereal diseases present what some public health workers regard as our most important health problem and yet little was done in an official way for their scientific prevention until within the past generation.

Importance.—Syphilis did not appear in the civilized world until 1493. There is evidence (*Journal American Medical Association,* June 12, 1915, Vol. LXIV, 24, p. 1962) that it was carried to Europe by the crew of Columbus on the return of his first voyage. By those members of the crew who joined the army of Charles VIII of France it was carried into Italy with the invasion of that country for the conquest of Naples in 1494. The epidemic which began there rapidly spread over all Europe with the most serious consequences, for the disease was then new and its course was extremely rapid and severe.

The seriousness of this disease has not been realized because its existence has been hidden. Until recently the only accurate data which we have had regarding the presence of the disease were secured from military organizations. It has been easy to conceal the presence of the disease in civil life because the infected individual is not physically incapacitated during its early stages. Kober (*Transactions Association American Physicians,* Philadelphia, 1911, Vol. XXVI, p. 155) gives a table showing the prevalence of the disease in certain military groups for specific years.

The variations of this table as well as more recent figures from our own army indicate that much may be done to limit the amount of infection. The following figures are taken from a statement of Colonel P. M. Ashburn, contained in *Report of Hearings* (H. R. 5123) *Excluding Advertising of Cures for Venereal Diseases from the Mails.*

We have recently learned more about the venereal diseases in civilian as well as military life. That venereal disease control is a civilian as well as a military problem is shown by Dr.

W. A. Sawyer, Major M.C., U.S.A. (*American Journal of Public Health,* May, 1919) who states the result of special reports rendered by Camps Upton, Dix, Meade, Lee and Pike for a period of 24 weeks from March 29, 1918 to November 15, 1918. Taking these five camps together the annual venereal disease rate for the entire period was 347.88 per thousand men. The rate for cases contracted in civil life and recorded as of the

DIFFERENTIATED INFECTIONS PER THOUSAND MEN

	Year	Syphilis	Chancroid	Gonorrhea	Total
U. S. Army	1909	30.45	30.77	135.77	196.99
U. S. Navy	1909	26.49	28.23	105.11	159.83
Japanese Navy	1907	....	....	.....	139.75
British Navy	1908	37.46	17.87	67.16	122.49
British Army	1908	35.1	28.23	40.7	75.8
Japanese Army	1907	10.1	10.4	17.1	37.6
Prussian Army	1907	4.4	2.1	12.2	18.7

U. S. ARMY VENEREAL INCIDENCE RATE PER 1,000 MEN

YEAR	RATE	YEAR	RATE
1911	163.49	1914	110.69
1912	136.70	1915	107.71
1913	99.22	1916	103.35
		1917	113.82

Incidence in Camps during War per 1,000.....60
Incidence in A. E. F. during War per 1,000.....45

date when first discovered was 336.96, while the rate for cases contracted after enlistment was only 10.92. Less than $\frac{1}{30}$ of the 42,032 cases in these camps were contracted after enlistment. Major Sawyer believes that for all the troops in this country including the organizations that had been longer in the service than the newly drafted men mentioned above five to one was a close estimate of the ratio between the cases contracted before enlistment and those contracted afterwards.

In spite of prompt isolation, thorough and proper medical treatment, the compulsory use of prophylactic stations, the elimination of prostitution so far as possible in the region of camps and a thorough educational program, there was a loss

to the army representing 2,195,000 days of service between April 1917 and September 1918 (*United States Public Health Service Reports,* Oct. 24, 1919). However, even in the absence of specific records we may be certain that this is a relatively slight time loss compared with that of previous wars.

Some idea of the more serious effects of syphilis are found in a study of Mattauschek (*Medicinische Klinik,* 1913, Vol. IX, p. 1544) who investigated 4,134 cases of the disease occurring among officers of the Austrian Army between 1880 and 1900. Of these officers 14.64 per cent were dead or disabled as a result of the disease. Of this group 20 had died, 198 had severe paresis, 113 had locomotor ataxia and 132 had cerebrospinal syphilis, 80 of whom were insane.

But these figures do not tell the whole story because the disease although hidden from the public greatly reduces the vitality of its victims and an early death is likely to occur from a variety of other causes. Very few of the insurance companies will accept syphilitics as risks and even those companies which accept cases after thorough treatment usually refuse to carry the individual after 55 years of age.

Nature of the Disease.—When an infection is produced by Treponema pallidum there first occurs a hard indurated ulcer or chancre in the skin or mucous membrane at the site of the initial infection. But the spirochetes soon invade the whole system and the second stage of the disease is marked by fever, anemia, the involvement of lymph nodes, and eruptions upon the skin and mucuous membranes. The mucous patches in the mouth appear at this time and the disease is highly infectious. During the third stage of the disease localized granulomatous growths (gummata) appear in the various organs of the body and it is following this stage that the serious effects upon the central nervous system are produced.

Transmission.—The spirochete of syphilis has been shown (Zinser and Hopkins: *Journal American Medical Association,* Vol. LXII, p. 23, June 6, 1914) to persist on a moist towel

for 11½ hours. It does not resist dryness and will not grow after having been dried on a slide for one hour. It is a relatively frail organism but of such viability as to be transmitted in other ways than through sexual approach. In fact accidental infections, contracted outside of venery, are more common than is ordinarily supposed. Even a slight scratch in the skin is sufficient to permit the introduction of the virus as has often been demonstrated by infections upon the hands of surgeons and in the practice of midwifery. It is possible for the disease to be transmitted by kissing, or by the use of common drinking cups or common towels. Dental instruments, the barber's razor, pipes, spoons, or glasses, may convey the infection if proper precautions are not used. This possibility for innocent infection makes the disease a menace to every member of the community because syphilis is present in every class of the social scale.

Syphilis is transmitted congenitally from infected parents to children. It is believed that the father cannot infect the fetus directly even though the spirochetes have been found in the seminal fluid. The wife of a syphilitic husband is practically sure to become infected, and the germs of the disease enter the fetus through the placental membrane from the circulation of the mother. In congenital syphilis, therefore, the mother is certainly infected, and the father is usually, but not necessarily infected. The consequences of syphilis, such as serious abnormalities of the nervous system may be transmitted to the offspring without congenital infection.

Immunity.—There is no true immunity to syphilis. No one is naturally immune to the disease and there is no cure without specific treatment. Even having had the disease and having been cured of it does not produce immunity. A person may be infected a second time.

Prevention.—A study of the methods of control enumerated for this disease in *Appendix A* will show that we have

recently made a good deal of progress in combating the malady. The emergency of war allowed the inception of a general campaign against it. Now the people as well as the physicians and health officers realize that the venereal diseases must be treated like all other contagious diseases if they are to be eliminated. Consequently it has been possible to establish measures to secure the reporting of cases, and their continued treatment. Aided by the Chamberlain-Kahn Bill, which provided conditionally for the distribution of $1,000,000 among the State Boards of Health each year for the two fiscal years beginning July 1, 1918 together with other appropriations for activities within the Bureau, the U. S. Public Health Service has conducted its campaign against venereal diseases by assisting in:

1. Securing prompt reporting.
2. Carrying on repressive measures.
3. Establishing free clinics for treatment.
4. Carrying on a general educational campaign.

Forty-six states (all but Pennsylvania, Nevada and the District of Columbia) adopted the regulations necessary to obtain their quota of Federal money for the first year. This involved the establishment of a special Department or Division of Venereal Diseases and the institution of proper control regulations. It is to be hoped that this disease will in the future receive the attention it deserves from health authorities and be handled like other communicable diseases.

Educational Program.—Perhaps the educational work carried on during the war was the most important part of the campaign because after all the continuation of suitable administrative measures depends upon the support of the community. The public should learn that syphilis is a communicable disease, that its presence can be determined by clinical examination or by the Wassermann laboratory test upon the blood serum. The disease is now curable by the use of salvarsan and allied products but the course of treatment

must extend over three years and must be followed out honestly and completely. The best doctors insist that the marriage of syphilitics should never be sanctioned unless they have undergone three years of thorough treatment and have subsequently been without symptoms for at least one year. Prophylaxis with calomel ointment within 20 hours after exposure is a fairly successful but not an infallible preventive against the disease.

We may hope that the serious consideration which has been given this disease in the United States during the past few years will give health authorities a keener appreciation of the seriousness of the problem, that it will make the medical and allied professions more aware of their responsibility in warning the patient against the spread of the disease and in keeping him under treatment until the disease is cured, and that the general public will understand the facts regarding the disease and insist that the practical and common sense medical and legal measures shall be taken for its control.

Other Venereal Diseases.—The possibility of the transfer of syphilis to the innocent is much greater than is the danger of a similar transfer of the other two diseases, but it is not intended to imply that syphilis is the only one of these diseases which is a serious public health problem. To be sure chancroid or soft chancre is a localized disease which is limited usually to the ulcer at the point of infection and in which serious sequelae from mixed infection is occasional but not common. But gonorrhea is thought by many to be a greater menace than syphilis. The complications of the disease resulting from the spread of the infection along the genital tract are most serious. The germ may enter the small glands along the genital tract producing an infection which is difficult to cure. It may close the ducts from the testes or ovaries making parenthood impossible. It may reach and infect the bladder or it may enter the blood. It is possible for this germ to cause rheumatism and it is one of the causes of blindness in newborn infants. We shall not

consider the public health facts concerning this disease beyond the brief statement in *Appendix A;* but we do want to contradict the idea, which is sometimes held by the uninformed, that this is not a serious disease. Few diseases are more to be dreaded or demand more prompt and expert medical care.

COMMON COLD

It may seem strange that the common cold should be listed here as the third great health problem but a moment's consideration will show that it is the most widespread of the communicable diseases. It is *continuously pandemic.* Always and everywhere in large population groups common cold is present to a limited extent. We pay little attention to the disease because it is not fatal and there are no good figures to show us what a tremendous loss it really produces.

Let us consider merely the economic loss from this disease. Is it not safe to assume that the average workman loses two days a year from a cold? If this is true then thirty million people who are employed in industry lose a total of sixty million days work. If you reckon the average wage as $4.00 a day here is nearly a quarter of a billion dollars lost in wages alone. Add to that the cost of decreased production and the loss from throwing out of employment other people in the same department or depending upon the work of the absentee and the loss becomes truly appalling. And this does not take into consideration the loss of efficiency during the days when the individual works with a cold or the general impairment of health which colds produce. Moreover the figures are for factory workers only. According to Frankel and Armstrong colds take more money out of the workers' pockets and keep more children out of school than any other disease.

Are we justified in saying that common cold is not a serious disease merely because it does not produce death? It is an acute infection of the nose, pharynx, tonsils, larynx, trachea or upper bronchi; and we know that neuritis, rheumatic

fever, pneumonia and rapidly progressing organic diseases often follow these conditions.

The Cause of Colds.—Colds may be described as simple and infectious. The simple cold may be caused by certain thermal, mechanical, or chemical irritants, resulting in congestion, a serous discharge from mucous membranes, and real discomfort. It may be due to sudden chilling of the body, weary after long hours in an overheated office; or one may lack a sufficiently vigorous circulation to resist the depressing effect of prolonged exposure of a portion of the body. Driving along a dust-laden road and certain agricultural or industrial occupations may cause irritation of the respiratory tract. Polyps, adenoids, enlarged tonsils, or deviated septum may set up a catarrhal condition or by mere mechanical obstruction give rise to symptoms of a simple cold. Certain pollens, as in hay fever or rose cold, and disturbing fumes of a laboratory may cause a similar condition.

The infectious cold, however, is not merely a congestion. It is a true infection superimposed often upon a neglected simple cold or upon any condition lowering the body vigor and resistance. The direct cause may be one or more of a variety of bacteria such as the staphylococcus, the streptococcus, pneumococcus, or the bacillus of influenza or catarrh. Many of these organisms are normal inhabitants of the mouth and nasal passages, but remain inert so long as one's resistance is at par or above. There is some evidence that these organisms may be secondary invaders and that the primary cause of colds may be an ultramicroscopic virus.

Catching Cold.—Every one knows by practical experience that an infectious cold is as contagious as many other infectious diseases. It runs through a household, a school, an office or factory, seeking especially those who have worked too hard, had too little sleep, or who are debilitated from any cause whatever. The people who contaminate clothing, books and furniture, who share apples, pipes, or powder

puffs, who cough and sneeze promiscuously, are the ones who make it impossible to conquer the spread of colds.

Sitting in a draft has an effect upon the development of a cold through the medium of the vasomotor system. When a cool wind reaches the skin of a normal individual, his vasomotor system reacts by removing the blood from the skin and thereby lessening the rate of heat loss. Removing the blood from the skin about the face, shoulders, and back of the head will congest the blood vessels in the interior. This, combined with the passage of cooler air over the respiratory membranes, may leave a watery or serous exudate upon the inner surfaces of the mouth and nasal passages. Thus bacteria, which may be present normally, or which have been recently acquired, find an opportunity to develop rapidly on these congested surfaces. Furthermore if the cooling effect is long continued, the temperature of the body is reduced and in this way the resistance is lessened. If the vasomotor system of the body is in poor condition, bodily adjustments to changes in temperature are less efficient and drafts are more likely to produce injurious effects. The development of an active and well-trained vasomotor system and the maintenance of high general vitality through proper food, sleep, and exercise are important factors in avoiding common cold.

Conditions which cause a continual irritation in the nose and throat also predispose to colds. Chronic catarrh, enlarged tonsils, polypus, deviation of septum and adenoids are examples. No doubt a dirty mouth is more likely to harbor the bacteria which may produce common cold than a clean mouth. The quality of the air passing over the respiratory passages is also important. Poor ventilation which allows the air to become too dry or dusty will set up undesirable nose and throat irritation. The air should be fresh and of suitable temperature. If the home or work place is too warm the sudden change of going out into the open will congest the breathing passages. It has been pointed out that in the coldest

weather it is the passengers in the stuffy carriages of the train who catch cold and not the fireman and engineer.

Since the organisms which produce cold are almost constantly in the mouth and nose the opportunities for infection are innumerable. Dr. Chapin has stirred the imagination by asking us to consider what would be the result if the secretions from the mouth and nose were of a bright color. If each individual shed from these cavities a different shade of an intense red dye it would be appalling to see how quickly the surroundings would take on a rosy hue. The fingers are constantly going to the mouth and nose and would quickly become a deep red color. The handkerchief would become quickly dyed, we would exchange material with the people with whom we shake hands. The door-knobs, trolley car-straps, our desks, books, and instruments would all acquire the color far too rapidly. Perhaps it would be fortunate if this could happen to us for a day. We would certainly have a revelation as to the amount of care which we should use in preparing and serving our food, and we might wish to abolish the habit of hand shaking.

There are three important rules for the prevention and treatment of colds:

(1) Remember that colds are spread by organisms in the secretions of the nose and throat, and *try to avoid infection.* We should be much more careful in avoiding contact with persons who have colds. We should not let people cough or sneeze in our faces and we should avoid using common eating or drinking utensils. We must educate or train ourselves in habits of sanitation or cleanliness as those words are interpreted under the germ theory of disease.

(2) *Avoid predisposing causes.* Drafts, poor food, extreme fatigue, lack of sleep, and bodily defects lower the resistance of a person so that colds may be acquired more readily. Do not neglect the duty to yourself of keeping in good physical condition.

(3) *When you feel a cold coming on go to bed.* This may seem a severe remedy but there are many reasons for doing it. Colds are most contagious during the early period and if a person isolates himself in bed he is preventing contagion as well as taking the best possible care of himself. The reconstructive forces of the body work best when a person is resting quietly in bed under proper conditions of temperature and nutrition. The body is rested and strengthened and the danger of increasing the severity of the disease by exposure to cold, damp and fatigue is eliminated. To stay in bed for a day or two when a cold is first coming on is perhaps the best economy of time as well as a "safety first" procedure. Often making the body—and especially the feet—thoroughly warm, increasing the intake of liquids and using a laxative with such other medication as your physician may suggest, followed by twelve or fifteen hours in bed, will break up a cold which is just setting in.

CHAPTER XII

FOOD CONTROL

Thus far we have considered food from the standpoint of diet. Under food control we shall consider the adulteration and sanitation of foods.

FOOD ADULTERATION

Cost of Adulteration.—It might be said that the prevention of food adulteration is more for the purpose of protecting the pocketbook than for protecting the health. The fraud practiced in food adulteration may sometimes be harmless but, if the adulteration reduces the nutritive quality of a food and adds some poisonous or infected substance the culprit who practices food adulteration not only robs the consumer but attacks his health.

Some people have the mistaken impression that almost all food is adulterated. Although the amount of adulteration varies in different states according to the nature of the Pure Food Law and the efficiency of law enforcement, still the foods which are adulterated are greatly in the minority. Considering the country at large it has been estimated that 15 per cent of the food consumed is adulterated. If this is true, based on an estimate of a $3.00 weekly expenditure per capita, the people of the United States are paying about two and a half billion dollars a year for adulterated, low grade or inferior food. If we accept the figures of experts who estimate that 2 per cent of adulterated food is injurious to health we find that the American people are paying yearly over $46,000,000 for food which actually brings them definite physical injury. Comparing present conditions with expert studies made several years ago it appears that Massachusetts saves over a million dollars for the public annually by the enforcement of the Pure Food Law.

Nature and Cause of Adulteration.—Food adulteration has now become a highly specialized art. Mixing sand with sugar and making milk out of chalk are not practiced because the detection of such simple fraud is too easy. The man who adulterates food now employs the skill of the chemist and an ingenuity equal to that of the theater "make-up man" in preparing his products. Coffee has been found which consisted of molasses and flour molded into the shape of coffee berries. American cotton-seed and peanut oil from the southern states have been sent abroad and refined then returned to us as pure Mediterranean Olive Oil. It is only by combating the craft of the manufacturer with the skill of the trained analyst that this type of food adulteration can be detected.

Keen competition and the desire for greater profits are important in causing food adulteration. People demand goods out of season and foods from distant parts of the world at cheap prices. The American wants goods done up in fancy packages, stamped with foreign labels, and served in an extravagant fashion. It is no wonder that many food manufacturers have discovered with Barnum that "the public likes to be humbugged."

Pure Food Laws.—It is not the purpose of a Pure Food Law to prohibit the making of cheap foods or even of second quality foods, but it does insist that these foods shall be sold for what they really are and not passed off upon the public for first quality materials. It is good to have second quality foods in the market if they are clean and wholesome because they are inexpensive. For example, catsup which is made largely from tomato skins, may be nearly as good as that made from the fleshy part or inside of the tomato, provided that the material is properly washed and sterilized; for the difference in food value in a condiment is not important. What we wish to prevent is the use of dirty tomato skins prepared in an unsanitary manner or the sale of second grade catsup under misleading labels. The public is entitled to know what it is buying.

According to the Federal Pure Food and Drug Act which was passed in 1906 a substance is considered adulterated:

(1) If a substance has been mixed with it to reduce the quality or strength. (Cocoa shells mixed with cocoa or chocolate, or watered milk.)

(2) If any substance has been substituted wholly or in part. (Cottonseed oil for olive oil, cane sugar for maple sugar.)

(3) If a valuable constituent has been wholly or partly abstracted. (Skimmed milk.)

(4) If it is mixed, colored, powdered, coated or stained in any manner whereby inferiority is concealed. (Lemon extract colored with a yellow dye, bleached flour.)

(5) If it contains any added poisonous or any other added ingredient deleterious to health. (Formaldehyde, arsenic, lead, salicylic acid, boric acid or benzoates.)

(6) If it consists in whole or in part of a filthy, decomposed or putrid animal or vegetable substance, or any portion of an animal unfit for food or if it is the product of a diseased animal, or one that has died otherwise than by slaughter. (Oysters contaminated with sewage, wormy figs, embalmed beef, etc.) [Under this clause reasonable sanitary requirements can be enforced.]

The reason certain foods continue to be adulterated in spite of this law is because the adulteration is so difficult to detect. For example, the sugar of the maple is identical chemically with cane sugar and it has been impossible to detect the fraud. The result is that more Vermont maple sugar is made outside the state than all the trees in Vermont could produce. New "Vermont maple sugar" appears in the market long before the sap starts in the maple groves of New England. A Congressional Committee was once told of the experience of a Chicago firm which had sent to the trade 150 barrels of pure maple syrup. Of this 147 barrels were returned with the complaint that it was too strong. Mixed with cane syrup

this same lot was again sent out and only praise was had from the buyers.

Misbranding.—The Food and Drug Act requires that no drug or article of food shall be falsely labelled as to its contents or as to the state or country in which it is manufactured or produced. A food is deemed to be misbranded:

(1) If it be an imitation of or offered for sale under the distinctive name of another article.

(2) If it be labeled or branded so as to deceive or mislead the purchaser, or purport to be a foreign product when not so, or if the contents of the package as originally put up shall have been removed, in whole or in part, and other contents shall have been placed in such package, or if it fail to bear a statement on the label of the quantity or proportion of any morphine, opium, cocaine, heroin, alpha or beta eucaine, chloroform, cannabis indica, chloral hydrate, or acetanilide, or any derivative or preparation of any such substances contained therein.

(3) If in package form, and the contents are stated in terms of weight or measure, they are not plainly and correctly stated on the outside of the package.

(4) If the package containing it or its label shall bear any statement, design or device regarding the ingredients or the substances contained therein, which statement, design or device shall be false or misleading in any particular.

Law Enforcement.—The Federal Food and Drug Act applies only to foods imported or for interstate shipment. For such food products inspections are made and enforcement is secured by the United States Department of Agriculture. The purity of foods sold within the state is controlled by special state laws and these laws are enforced by state officials. Individual states usually maintain a Division of Food and Drugs under the State Department of Health. The samples are collected in various parts of the state. Each sample is numbered by the inspector who collected it and it is then placed in a locker in the partition wall of the laboratory. The inspector himself never enters the laboratory but opens the locker from the outside. Later the locker is opened from the inside by the laboratory technician and an analysis is

made, the report being rendered on the basis of the number used. In this way every suspicion of collusion between the inspector and analyst is avoided.

The state laws are usually similar to the Federal Food and Drug Act but frequently include additional regulations regarding special foods like milk, butter, sausages, etc. The state which fails to make and enforce suitable laws is in a particularly unfortunate condition because large food manufacturers dump poor products upon it.

Special standards for foods like milk, butter and vinegar may also be set up by municipal ordinance and such foods may be examined in the city public health laboratory. The most common local ordinance is that governing the sale of milk, the skimming or watering of which is determined by a variation from the normal proportion of the constituents produced by such a process. The composition of normal milk is as follows: Sugar 4.7%; fat 3.8%; total solids, 12.8%; refractive index, 37.5; solids not fat, 9%; specific gravity, 1.032; protein, 3.6%; ash, 0.7%.

FOOD SANITATION

The three most important problems in securing clean food involve the sanitation of milk, meat and prepared food supplies.

Milk.—Milk is used in enormous quantities as food. In 1926 the average American consumed as milk and milk products (cream, butter, and cheese) 55.3 gallons of milk, somewhat over 880 pounds. In 1928 he consumed as milk alone something over 240 quarts, or approximately 1.22 pints per day.

It is difficult to keep milk in a sanitary condition because it is not a clear fluid but a suspension which hides dirt readily. It is a good medium for bacteria to grow in, so that they rapidly increase unless the milk is kept at a low temperature. Moreover, milk must be produced at a considerable distance

from the point where it is finally used. Some of our large cities get milk from farms 300 miles distant. And it is particularly important that it should be kept clean because milk is the one animal food which is eaten raw in great quantities.

Bacteria which are not disease-producing cause two kinds

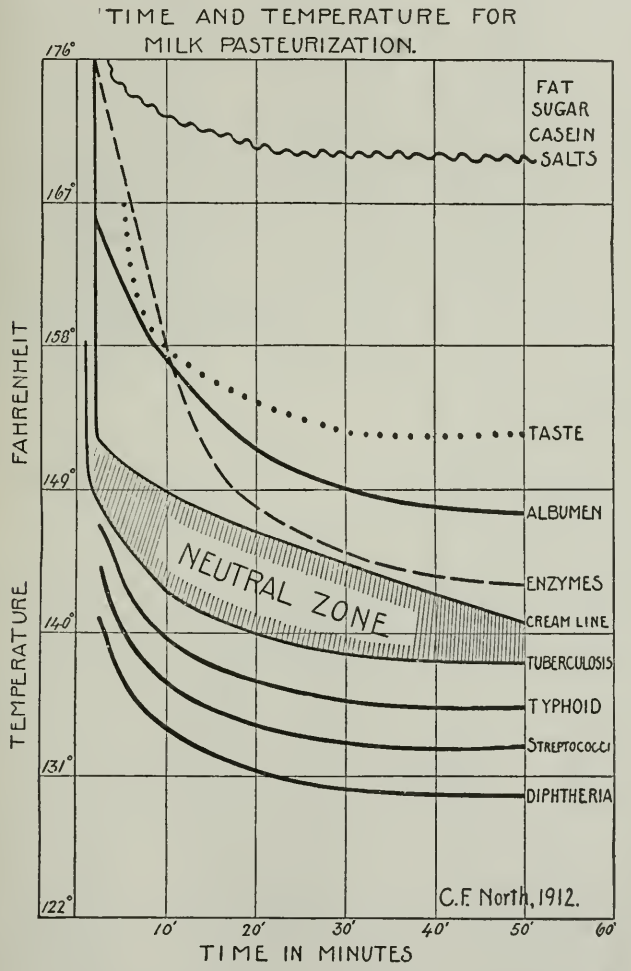


Fig. 38.—Chart showing the time and temperatures at which bacteria are killed and at which the quality of the milk is changed.

OFFICIAL DAIRY SCORE CARD

Owner or lessee of farm.....

P. O. Address..... County.....

Total number of cows..... Number milking..... Gallons of milk produced daily.....

Product is sold by producer in families, hotels, restaurants, stores, to..... dealer.

For milk supply of.....

Permit No..... Date of inspection....., 193

Equipment	Score		Methods	Score	
	Perfect	Allowed		Perfect	Allowed
COWS			**COWS**		
Health	6	.....	Clean	8	.....
Apparently in good health.....1			(Free from visible dirt, 6.)		
*If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed 5			**STABLES**		
(If tested within a year and reacting animals are found and removed, 3).....			Cleanliness of stables.....	6	.....
Food (clean and wholesome).....	1	.....	Floor 2		
Water (clean and fresh).....	1	.....	Walls 1		
STABLES			Ceiling and ledges.....1		
Location of stable.....	2	.....	Mangers and partitions.....1		
Well drained.....1			Windows 1		
Free from contaminating surroundings..1			Stable air at milking time.....	5	.....
Construction of stable.....	4	.....	Freedom from dust.....3		
Tight, sound floor and proper gutter....2			Freedom from odors.....2		
Smooth, tight walls and ceiling.....1			Cleanliness of bedding.....	1	.....
Proper stall, tie, and manger.....1			Barnyard	2	.....
Provision for light: Four sq. ft. of glass per cow.	4	.....	Clean 1		
(Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)			Well drained 1		
			Removal of manure daily to 50 feet from stable	2	.....
			MILK ROOM OR MILK HOUSE		
			Cleanliness of milk room.....	3	.....

Bedding	1				
Ventilation	7				
Provision for fresh air, controllable flue system 3			Care and cleanliness of utensils.....	8	
(Windows hinged at bottom, 1.5; sliding windows, 1; other openings, 0.5.)			Thoroughly washed 2		
Cubic feet of space per cow, 500 ft.....3			Sterilized in steam for 15 minutes.....3		
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., 0.)			(Placed over steam jet, or scalded with boiling water, 2.)		
Provision for controlling temperature...1			Protected from contamination.....3		
			Cleanliness of milking.....	9	
UTENSILS			Clean, dry hands.....3		
Construction and conditions of utensils.....	1		Udders washed and wiped.....6		
Water for cleaning.....	1		(Udders cleaned with moist cloth, 4; cleaned with dry cloth or brush at least 15 minutes before milking, 1.)		
(Clean, convenient, and abundant.)					
Small-top milking pail.....	5		HANDLING OF MILK		
Milk cooler.....	1				
Clean milking suits.....	1		Cleanliness of attendants in milk room.....	2	
			Milk removed immediately from stable without pouring from pail.....	2	
MILK ROOM OR MILK HOUSE			Cooled immediately after milking each cow..	2	
Location: Free from contaminating surroundings	1		Cooled below 50°F.....	5	
Construction of milk room.....	2		(51° to 55°, 4; 56° to 60°, 2.)		
Floor, walls and ceiling.....1			Stored below 50°F.....	3	
Light, ventilation, screens.....1			(51° to 55°, 2; 56° to 60°, 1.)		
Separate rooms for washing utensils and handling milk.....	1		Transportation below 50°F.....	2	
Facilities for steam.....	1		(51° to 55°, 1.5; 56° to 60°, 1.)		
(Hot water, 0.5.)			(If delivered twice a day, allow perfect score for storage and transportation.)		
Total	40		Total	60	

Equipment.....+Methods.....=.....Final Score

Note 1.—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

Note 2.—If the water is exposed to dangerous contamination, or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

*Alternate. If the milk is pasteurized by the holding process, score 5.

of changes in milk, putrefaction and fermentation. *Fermentation* usually results from the action of the lactic acid bacillus and produces the normal condition of sour milk by breaking down the milk sugar into lactic acid. Milk sours because the condition or time of storage has favored the development of acid-forming bacteria, its taste may be disagreeable but it is not injurious to the health. Indeed specially fermented milk has been recommended as healthful. When milk undergoes *putrefaction* the proteins are attacked by bacteria. Such milk is alkaline in reaction and bitter to the taste. It may be injurious to health.

There are always many harmless bacteria in milk but it may also contain the germs of communicable diseases. Everyone has heard of milk borne epidemics. Diseases from *animals* producing milk epidemics include tuberculosis, milk sickness, Malta fever, hoof and mouth disease, contagious abortion, and various streptococcus infections. The diseases which may be transmitted from *man* in milk are tuberculosis, typhoid fever, scarlet fever, diphtheria, septic sore throat, dysentery and diarrhea. The germs of these diseases increase in number rather than die out in milk and it is extremely important that both the cows and the milk handlers should be free from such diseases.

An idea of the details which have to be considered in producing clean milk may be obtained from an examination of the "Official Score Card," used by the United States Department of Agriculture for the purpose of rating dairy farms. (See pages 238 and 239.)

The problems of the health department do not end here however, because the milk must be kept cool and clean from the time it leaves the farm until it reaches the consumer. Frequently milk is a long time in transit and often it is rebottled before being finally delivered.

Pasteurization has greatly improved the milk supply of many cities as it has become more and more widely adopted.

This process of heating the milk to a temperature of from 64° to 68° Centigrade for 20 minutes kills most non-spore-bearing organisms. It is most valuable when the milk is pasteurized in the final container. If the temperatures do not go above 68° Centigrade the composition and taste of the milk are not changed.

Graded Milk.—Terms which are often used to describe various grades of milk are: Certified Milk, Inspected Milk, and Market Milk.

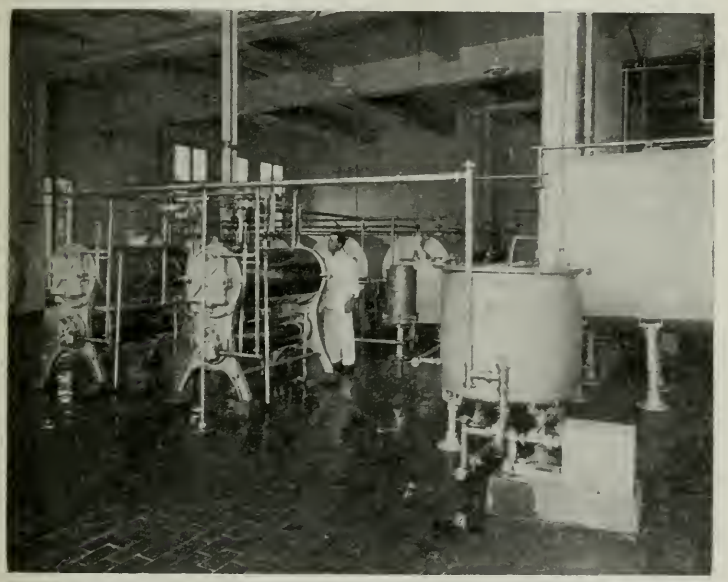


Fig. 39.—Modern plant for the pasteurization of milk. (Courtesy of the Borden Co.)

The American Association of Medical Milk Commissions has set the standards for *Certified Milk.* Such milk is certified by a Medical Milk Commission to be produced from healthy, tuberculin-tested cattle which are subject to veterinary inspection. The milkers and the milk handlers are given physical examinations to see that they have no communicable diseases,

the cattle are kept clean and are given proper food; proper sanitary precautions are taken during milking, the barn is clean, the milk is cleanly bottled at the dairy and kept cold. The bacterial count of such milk is less than 10,000 per c.c. It is delivered within 36 hours after it is produced.

Inspected Milk is of a somewhat lower grade but it comes from tested cows and it is secured and marketed under cleanly conditions. The bacterial count of such milk is less than 100,000 bacteria per c.c.

The term *Market Milk* is often used to describe milk which is below the standard of either of the above grades. Sanitarians believe that all milk should be pasteurized or certified.

The United States Public Health Service has issued a standard milk ordinance which has been widely adopted. This ordinance places the burden of safe milk on the local health officer. It requires him, at least every six months, to inspect all dairy farms and milk plants within his jurisdiction; to grade and regrade the output of these places, and announce through the press the standing of their product. It requires unmistakable labeling of all containers as to the nature of their contents, whether raw, pasteurized, or certified milk. It also describes in detail the approved dairy plant, its personnel, equipment, production, and marketing methods; and it urges all cities and communities to work toward this ideal at the earliest possible date. Copies of this ordinance, Reprint 1099, may be obtained from the United States Public Health Service, Washington, D. C.

Remade Milk.—Remade milk is a new product which is being used by hospitals and other institutions with good results. This is made by mixing dehydrated skimmed milk (milk powder) and unsalted butter or milk fat with water in an homogenizer. By this process milk may be dehydrated in dairy regions far from the cities and remade in the large centers of population producing a clean, and inexpensive product. Remade milk has a low bacterial count and a good cream line. It is not easily distinguishable from fresh milk.

Condensed, Evaporated and Dried Milks.—These products are produced through the conservation of milk by means of partial or complete drying. Whereas fresh milk contains about 12 per cent total solids, condensed milk contains 28 per cent, evaporated milk contains 25.5 per cent, and dried milk is reduced to a powder. The amount of milk fat should be not less than 3.25 per cent in fresh milk, 8 per cent in condensed milk, and 7.8 per cent in evaporated milk.

Many advantages are derived from this partial or complete desiccation of milk. It improves the keeping qualities by reducing the water content below the point necessary for bacterial growth. The bulk is reduced and consequently the transportation charges. It is possible to preserve in this way the seasonal surplus of milk or milk produced in remote sections. Sanitary control and honest labelling are, of course, important.

Condensed milk is partially dried, pasteurized but not sterilized, and then preserved with 40 per cent sugar. If it is not produced under sanitary conditions, its bacterial content may be very high.

Evaporated milk is unsweetened. It is heated to such a high temperature that it becomes sterile or nearly so. It keeps well and has practically all of the nutritional qualities of original milk.

Two processes are used in the preparation of *dried milk* or milk powder. By one method the milk is dried in a partial vacuum at a comparatively low temperature. In the other process the milk is first concentrated in a vacuum and then sprayed into a hot chamber. The product keeps well and has practically all of the nutritive value of fresh milk except that the antiscorbutic vitamin is reduced.

Meat.—Meat is inspected by Federal, State and Local Health Agents, and in large abattoirs an inspection both before and after killing is made. One reason for making such an inspection is to see that the animal is free from such diseases as tuberculosis, anthrax, trichinosis, actinomycosis, tape-

worm, septic and pyemic conditions. Later inspections of meat are to make sure that the meat has not become decomposed or infected. There is also a supervision over the processes of slaughter to see that the death of the animal is immediate and painless, that there is an immediate withdrawal of blood, that the intestines, hide and hair are promptly removed and that there is immediate cooling.

Dangers in Meat.—The important health dangers which exist where meat is not inspected are due to the following causes:

(1) *Paratyphoid Bacilli.*—If animals have had fevers, diarrhea or local suppurations and especially if the conditions of slaughter are not clean, meat may have picked up these organisms of the typhoid group, which produce diarrheas of varying intensities.

(2) *Bacillus Botulinus.*—This bacillus, which produces botulism, is an anærobic, spore-forming saprophyte, which grows outside the body and may infect meat and develop in sausages which are not kept under sanitary conditions. This organism produces an exotoxin which causes the typical symptoms of botulism when the infected food is eaten.

(3) *Trichina Spiralis.*—The small roundworm which produces trichinosis has a normal cycle in rats but the disease may extend to swine. When this happens the larvæ become encysted in the muscle of the pig producing a condition known as "measly pork." When such pork is eaten without being thoroughly cooked the larvæ develop into mature worms in the human intestines. Each female produces about 500 living young and these embryos penetrate the tissues of the bowels and find their way into the muscle of the human subject producing pain, fever, soreness and other symptoms of the disease. Microscopic examination of meat is fairly successful in detecting the presence of these parasites. All pork should be cooked until it is thoroughly white and hams should be boiled for ½ hour for every kilogram weight to kill the organisms.

(4) *Tænia Solium.*—The encysted larvæ (bladder worms) of the pork tapeworms may be eaten in pork. This infection is particularly dangerous because the larvæ develop in man and may find their way to important parts of the body such as the eye, or the brain.

(5) *Tænia Saginata.*—This tapeworm occurs only in cattle and in man. The larvæ are found embedded in beef and when such meat is eaten they develop in the human intestines. This tapeworm is not dangerous, although it causes anemia and is often difficult to expel. Man is infected from uncooked beef while cattle are infected by eggs passed in human feces.

(6) *Tænia Echinococcus.*—This minute tapeworm of the dog frequently infests cattle, swine, horses and sheep, reaching the digestive tract of the new host in the form of the eggs which are passed in the feces of the dog. The embryoes develop in the digestive tube, pierce the mucosa and become encysted in various tissues and organs of the body. Man like the other animals mentioned is infected from the dog by ingesting eggs which are passed in the feces.

(7) *Ptomaine Poisoning.*—Much less is heard recently of ptomaine poisoning which has been regarded as being produced by a poisonous substance formed in the decomposition of proteins. Many cases of supposed ptomaine poisoning have been found to be infections or intoxications produced by such organisms as paratyphoid or botulinus.

Prepared Food.—The sanitation of prepared food is secured through the supervision of restaurants, food stores, and other places where food is sold. The score card for food establishments shown on page 246 indicates the factors of cleanliness which are considered.

Two factors not mentioned in such a score card but of extreme importance in food sanitation at restaurants and hotels are the physical examination of food handlers and the method of dish washing. A waiter or food handler who is tuber-

FOOD ESTABLISHMENTS
SCORE CARD

LOCATION .....

DISTRICT ..... ROUTE NO. .....

KIND OF STORE .....

NAME OF PROPRIETOR..... DATE .....

EQUIPMENT	Perfect	Allowed
Construction:		
Floors	3	
Walls	2	
Ceilings	1	
Arrangement:		
Proper rooms	4	
Conveniences	3	
Light	5	
Ventilation	5	
Screens	5	
Cellar	3	
Plumbing:		
Sufficiency, Kind, Quality, Location, Condition — Water-closets	10	
Sufficiency, Kind, Quality, Location, Condition — Sinks	10	
Ice boxes	10	
Drainage	4	
Counters and show cases	5	
Utensils	5	
Hot water facilities	15	
Cold water facilities	10	
Total	100	

METHODS	Perfect	Allowed
Cleanliness:		
Floors	5	
Walls	2	
Ceilings	2	
Doors	1	
Windows	1	
Ice Boxes	10	
Counters and show cases	5	
Sinks	5	
Utensils	10	
Employees	5	
Good order	1	
Free from odors	2	
Free from flies and other insects	6	
Food articles		
Condition	15	
Storage	10	
Handling	5	
Cleanliness	5	
Waste Receptacles:		
Adequate	5	
Condition	5	
Total	100	

Score for equipment.....multiplied by one equals .....

Score for methods.....multiplied by two equals.....

Total to be divided by three to obtain final score.....

Milk record

Milkman .....

Number quarts sold daily.....

Ample ice .....

Is milk on ice? .....

Are milk utensils thoroughly clean? .....

REMARKS

(Under this heading denote unusual conditions as sleeping accommodations, the presence of domestic animals in or about shop or rooms, noncompliance with regulations and infractions of statute laws.)

.....

.....

..... *Inspector.*

CITY OF BOSTON—HEALTH DEPARTMENT

culous or who is a typhoid carrier may infect food prepared in the most cleanly kitchen. The case of one such carrier, "Typhoid Mary," has become famous. This woman, who was employed at various places as a cook, infected over a score of people with typhoid fever before it was learned that she was a carrier. No person harboring the germs of typhoid or any other infectious disease should be allowed to handle food. Both in the home and in public eating places the germs of tuberculosis, common colds, influenza, septic sore throat and other diseases may be carried from diseased persons to healthy individuals on unscalded dishes much more often than we realize.

CHAPTER XIII

WATER SUPPLY

The danger of transmitting disease by polluted water has been well recognized since the epidemic of the Broad Street Well in 1854. We know now, as they did not then, that the danger is not from a particular and peculiar poisonous substance, but rather from the germs of infectious disease which remain alive in the water and reproduce the disease by multiplying in the digestive tract of the individual who has drunk thereof. Water-borne epidemics of typhoid fever, cholera, and diarrhea have been so numerous and so important that the people at large now have a very keen appreciation of the danger from a polluted water supply.

Although freedom from disease germs is a most important characteristic of good water, there are many other important considerations in securing a city water supply. Indeed if disease germs were the only menace, that danger could be avoided by always boiling water before drinking it. Such a precaution is used by travelers and explorers where the source of water is unknown. In China, where the population is dense, most of the wells are polluted and the people are saved from intestinal disease by their tea-drinking habit, through which they avoid the use of raw or unboiled water.

Important as water is for the body there are many ways in which it is used outside the diet and it is because so much is needed that it is difficult to secure a satisfactory supply. The average American city uses 100 gallons of water a day for every inhabitant. Water has the property of picking up dirt so readily and the outlying districts of cities become settled so soon that the water shed or drainage basin from which water would naturally be secured contains many habitations and the opportunities for pollution with human or animal waste are innumerable.

What Is Good Water?—The characteristics of a good water supply may be enumerated as follows:

1. *It should be free from the germs of infectious disease.*

2. *It should be free from poisonous metals, particularly lead.* It is well known that lead is a cumulative poison which is readily taken up by the body in small quantities and which has serious effects particularly upon the stomach and the nervous system. "Painter's colic" and "wrist-drop" are typical symptoms of this type of poisoning. Some waters have a much greater solvent action upon lead pipe than others.

3. *The water should be of suitable temperature,* certainly less than 80°F. If the water is too warm it will not be used as much as it should be for drinking purposes.

4. *The water should be low in color,* otherwise it will not be acceptable. Color may be harmless but a highly colored water will not be generously used.

5. *It should be clear,* i.e., free from suspended matter, like sand or clay.

6. *It should be odorless.* The odor of water most frequently comes from small or microscopic plants which grow in the lake or reservoir and which of themselves are entirely harmless. The odors which they produce, however, are distinctly disagreeable and may make the water offensive.

7. *The water should not be too hard,* since hard water makes laundering particularly difficult. This is caused by the reaction of the calcium or magnesium salts of hard water in displacing the sodium of soap. Such a reaction forms a precipitate of the above mentioned salts and enough soap must be added to use up all the calcium and magnesium in the water before any lather is produced. Hard water is therefore unpleasant to use on the flesh and costly for laundering purposes.

8. *It should be practically free from iron.* Otherwise clothes will be stained or "rusted" in the laundering process.

Sources of Water Supply.—There are two kinds of water supplies, surface waters and ground waters. We can better

appreciate their differences if we follow the history of water after it falls as rain. It may fall directly into rivers or lakes, or it may reach them by running over the surface of the ground. More often it reaches them by soaking through the soil just beneath the surface, for ground water is always in motion, moving from 0.2′ to 20′ per day, toward visible or underground rivers or in the direction of their flow. Water taken directly from rivers and lakes or temporarily stored in reservoirs constitutes a surface water supply.

Surface Water, which has washed over the ground and which in rivers and lakes furnishes the home for innumerable plants and animals, naturally contains many things besides hydrogen and oxygen; in fact chemically pure water is difficult to secure even in the laboratory. In nature water which appears perfectly clear to the eye may reveal many things upon chemical and microscopic examination. It contains dissolved oxygen, upon which the fish and other animals live, nitrates and other salts used by plants, carbon dioxide and perhaps ammonia, marsh gas and other chemical substances. An examination with the microscope reveals particles of dirt, bacteria, minute plants and animals, bits of wood and fibers of one sort or another. If this water has passed over polluted ground, filth and disease germs may be added to its contents.

Ground Water is obtained from wells of various depths and may be free from many of these substances, which are caught and held back as the water strains through the soil. Sandy or gravelly soil is the best filter for water, and in passing through 100 feet of sandy soil water will be purified for a considerable period. Finally, however, even this soil would become polluted and a well 100 feet from a privy or other source of pollution would be endangered. When in place of sand we have a broken formation, as is the case with limestone or some types of ledge, there may be a break having a rivulet by which pollution may reach the well directly.

The difference between surface wells and deep wells is one of character and not primarily one of depth. A *surface well*

is one which does not reach through the first impenetrable layer of soil; while a *deep well* does go through the impervious layer and furnishes its water from the water table. A deep well may be a quiet well from which the water is pumped, or it may be an artesian well from which the water flows freely. The artesian well is produced by a water pressure beneath the impervious layer of soil which is sufficient to throw water to the surface.

Well water has been used for generations. It is usually clear, cold and sparkling and most people believe that well

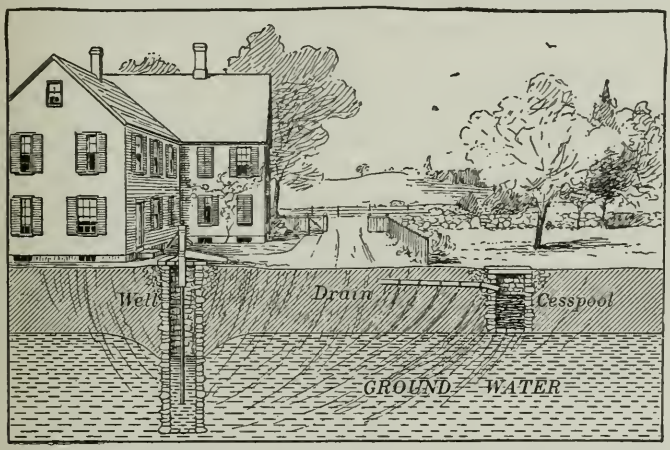


Fig. 40.—Wells may be polluted by water which soaks through the soil from privies or cesspools. The danger of pollution is less in sand and gravel soil but these may finally become saturated and permit infection. (The Human Mechanism.)

waters are almost always safe. The contrary, however, is frequently the case, especially where wells are dug in unsewered villages where the soil is heavily polluted. In fact a clear and sparkling water *may* be more dangerous than the yellow and smelly water of a stagnant pond for, as we shall see later, water purifies itself by storage. The water from deep wells is usually more reliable than that from shallow wells because it has been in the ground longer and has worked its way through the soil for a long distance. Any student

of bacteriology knows that a glass of water may contain thousands of typhoid bacilli without showing the slightest trace of sediment. When people generally realize this they will cease to judge the quality of drinking water by its appearance.

WATER ANALYSIS

A careful examination is necessary to really determine the quality of a water supply. Such an examination includes four factors: (1) a study of the environment, (2) a bacteriological examination, (3) a microscopic examination, and (4) a chemical examination.

1. **Environment.**—In order to estimate the value of water the sanitarian must know the nature of the water shed from which it comes; that is, the number of inhabitants in the drainage area, and the nature of the soil and slope of the drainage basin. A laboratory examination of the water at some particular time might be satisfactory and yet if the water came from a populous district with a clay soil and steep slopes, a heavy rain might wash great quantities of pollution into the stream or lake.

2. **Bacteriological Study.**—The second step is the bacteriological examination of a properly secured sample of the water. By plating out the water in gelatine or agar the total number of bacteria may be determined and by using different temperatures for incubating the Petri dish plates the number of water bacteria can be contrasted with the number that grow well at body temperature.

Tests* are also made to determine the number of bacillus coli in the water. It is not easy to detect typhoid bacilli or other disease germs when they are present but the colon bacillus, which is a normal inhabitant of the intestines, is easy to discover and determination of its presence gives a good in-

*Laboratory directions for making a complete water analysis may be found in *"Standard Methods of Water Analysis,"* published by the American Public Health Association.

dication of the pollution or purity of the water in question. Of the various bacteriological tests which are made these two, the total bacteria and the presumptive test for B. coli, are the most important.

3. **Physical Tests.**—The physical tests which are made upon water include an examination for odor, temperature, color and turbidity.

The *color* is expressed in parts per million and is determined by comparing the water with a platinum-cobalt standard. True color is produced by substances in solution, many of which come from vegetable tissues soaking in the water.

The *turbidity* is likewise expressed in parts per million and is usually determined by comparing the water with a standard suspension of silica. It is produced by finely divided suspended matter like clay, silt and microscopic organisms.

The *odors* are described as fishy, vegetable, aromatic, grassy, earthy, mouldy, musty, disagreeable, peaty or sweetish. They are caused by decomposing organisms, fermenting material, or gases like hydrogen-sulphide or methane. Many of the tiny green plants, particularly the diatoms have quite distinctive odors.

It will be seen from the above that the physical examination of water tells much about its condition but little about its sanitary quality.

4. **Chemical Tests.**—The most important chemical tests from the sanitary point of view are the tests for nitrogen in its various forms and the test for chlorine. The nitrogen tests give us an index of the quantity, the nature and the freshness of pollution by nitrogenous waste material. The test for chlorine is a valuable indicator of pollution because in soils free from salt deposits the only source of chlorine, except for salt mists brought in from the ocean, is the waste of the body.

Nitrogen and the Nitrogen Cycle.—To understand the meaning of the nitrogen tests we must recall for a moment the story of the nitrogen cycle. We find this important ele-

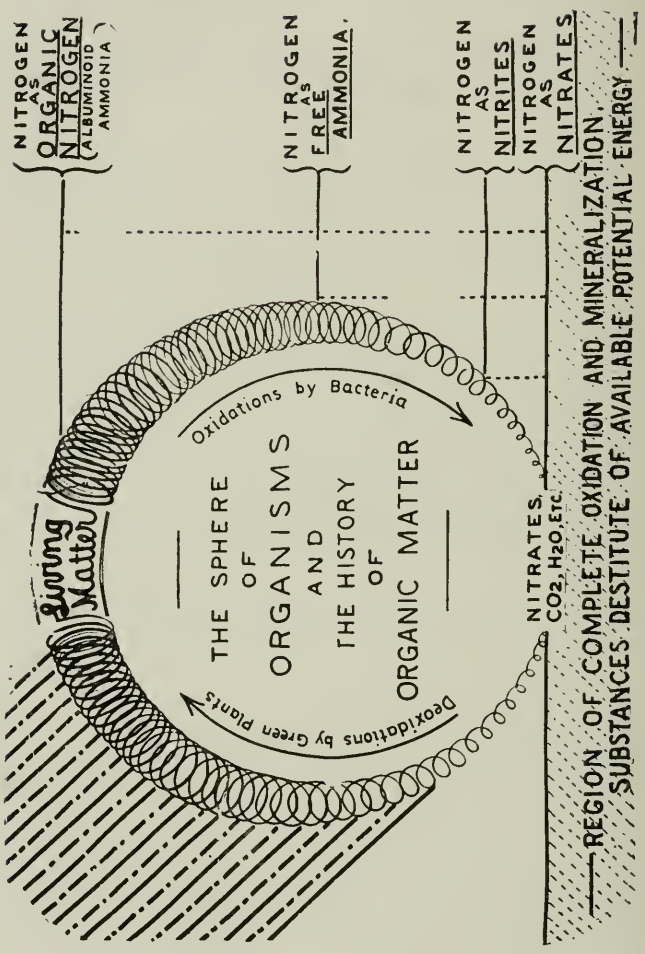

NITROGEN AS ORGANIC NITROGEN (ALBUMINOID AMMONIA)
NITROGEN As FREE AMMONIA.
NITROGEN AS NITRITES
NITROGEN AS NITRATES
Living Matter
Oxidations by Bacteria
Deoxidations by Green Plants
THE SPHERE OF ORGANISMS AND THE HISTORY OF ORGANIC MATTER
NITRATES, CO2, H2O, Etc.
REGION OF COMPLETE OXIDATION AND MINERALIZATION.
SUBSTANCES DESTITUTE OF AVAILABLE POTENTIAL ENERGY

Fig. 41.—The nitrogen cycle.

ment going through an endless chain of changes. Inorganic nitrogen is taken up by plants in its simple inorganic condition and transformed into plant protein from which in turn it is transformed into animal protein by herbivorous animals. When these complex proteins from living animals are left exposed in the air or in water they return to their simple condition by a series of definite oxidation processes. In this series of changes the nitrogen is found consecutively in complex proteins, albuminoid substances, ammonium salts, nitrites and nitrates. Special microorganisms carry out the last two steps. Ammonium compounds are acted upon by nitrosomonas and oxidized to nitrites. Nitrites are oxidized by nitrobacter to nitrates. In making a chemical analysis of water we can determine the amount of nitrogen in these various conditions.

The test for *nitrites* is particularly valuable because the test itself is very delicate and because nitrogen passes through the nitrite stage very quickly. The analysis will readily determine the presence of 0.01 parts of nitrites per million. Even this small quantity shows clearly that organic substances are being broken up in the water. This is an indication of fresh pollution for if the pollution were remote the nitrogen would be found in some of its more stable compounds.

The test for *free ammonia* determines the amount of nitrogen present in the water as ammonium salts, which are readily driven off on the direct distillation of slightly alkaline water. A large amount of free ammonia also indicates pollution, although it may be remote.

The test for *albuminoid ammonia* measures the amount of ammonia set free from nitrogenous organic matter by the action of boiling alkaline potassium permanganate. This is therefore a good index of the amount of easily decomposable organic matter in the water. It may come from plant substances or from animal wastes but when it is from a vegetable source the water is usually colored and the nitrogenous material is more stable. It therefore follows that a colorless

water should contain less albuminoid ammonia than the yellow waters of natural storage reservoirs.

Nitrogen in the form of *nitrates* is the final product of the process of oxidation or mineralization. These are the stable compounds which are used as food by plants in building up the nitrogen to the organic form. If the nitrates are high it indicates that a good deal of nitrogen has gone through the mineralizing process and therefore a high figure may indicate pollution even though it be remote. Good ground water may contain more nitrates than surface water because the nitrates of ground water are not used up by growing plants.

By a continued study of water supplies of various sorts a set of *standards* or limits can be set as to the amount of these various substances a good water may contain, although in every case, the final interpretation of the chemical analysis should be made by an expert. In general a safe water should not contain more of these substances than is indicated in the following table:

NITROGEN LIMITS IN A SAFE WATER SUPPLY EXPRESSED IN PARTS PER MILLION

Nitrogen as albuminoid ammonia 0.15 (colorless water) 0.4 (colored water).
Nitrogen as free ammonia 0.15.
Nitrogen as nitrites 0.01.
Nitrogen as nitrates. 1. (surface water) 2. (ground water).

Chlorine.—Chlorides occur mostly as the sodium salt and the results are usually expressed in terms of chlorine. As stated above waters coming from soils free from salt deposits receive chlorine from only two sources, salt mists blown in from the ocean and animal wastes, principally urine. (Human urine contains about one per cent sodium chloride.) It therefore follows that unpolluted waters near the ocean would contain more chlorine than those at some distance from the coast. By the analysis of a large number of samples from waters of known purity in various parts of a coast state the normal

amount of chlorine for each particular district can be determined and if a suspected water contains more than the "normal" amount of chlorine it may be justly concluded that an additional amount has been derived from pollution. It will be seen that it is not the number of parts per million of chlorine but the relation of the amount of chlorine to the "normal" which is taken into consideration in interpreting this chemical test.

5. **Microscopic Analysis.**—We have seen that disagreeable tastes and odors commonly arise from the presence of microscopic plants and animals in water. Their presence can be detected by straining some of the water through sand and then washing the microscopic organisms from the sand and examining the wash water under the microscope. In investigating a prospective water supply it is desirable to know whether it contains these troublesome organisms and in testing the water of an old supply it is important to learn of any increase in numbers or of the sudden appearance of any organism; because by treating the water with copper sulphate the objectionable plants may be killed and the disagreeable tastes and odors prevented.

This examination follows the so-called Sedgwick-Rafter process in which 500 c.c. of the water is filtered through sand from which the organisms are washed with 5 c.c of wash water. This concentrated sample is examined on a special slide in which the water is just one millimeter deep. A special micrometer is used in the microscope to mark off a field one millimeter square so that in looking through the microscope the number of organisms in a cubic millimeter of the concentrated sample may be determined. By counting a number of fields a fair average may be obtained and the number of organisms in the original sample may be computed. This test is regularly made in city water laboratories because the number of objectionable organisms varies at each season of the year and it is important to determine their increase before a nuisance is produced.

By the above tests the sanitary and aesthetic quality of a drinking water supply may be accurately determined and by the addition of special tests for hardness, iron, etc., its fitness for industrial purposes may be estimated. It is hardly necessary to repeat that the quality of a drinking water cannot be determined by its appearance to the naked eye.

WATER PURIFICATION

It frequently happens that safe water supplies are not available and some method of purifying the water must be adopted. There are three important methods in general use: (1) Storage, (2) Filtration, and (3) Chlorination.

Storage.—Storage is the natural way of purifying water and it is utilized by man in securing water from lakes and reservoirs. Bacteria and other particles settle to the bottom of standing water and what is often most important the bacteria themselves die of starvation or are devoured by other organisms.

It was the privilege of the author to study this process of natural purification in a small stream which received the partially purified sewage effluent from the city of Brockton, Massachusetts. (Reported as *"Studies on the Purification of a Sewage Filter Effluent by a Small and Otherwise Unpolluted Stream,"* by Weston and Turner in Contributions from the Sanitary Research Laboratory and Sewage Experiment Station, Volume X, M. I. T., Cambridge, Mass., 1917.) This study showed that the process of self-purification is largely biological and that still water purifies itself much more rapidly than running water, because in the latter case the plants and animals which assist in purification processes are swept away while in still water they accumulate in enormous numbers.

At the point where the pollution enters the stream there is a sudden increase in the number of bacteria. These break down the organic substances of pollution but they themselves

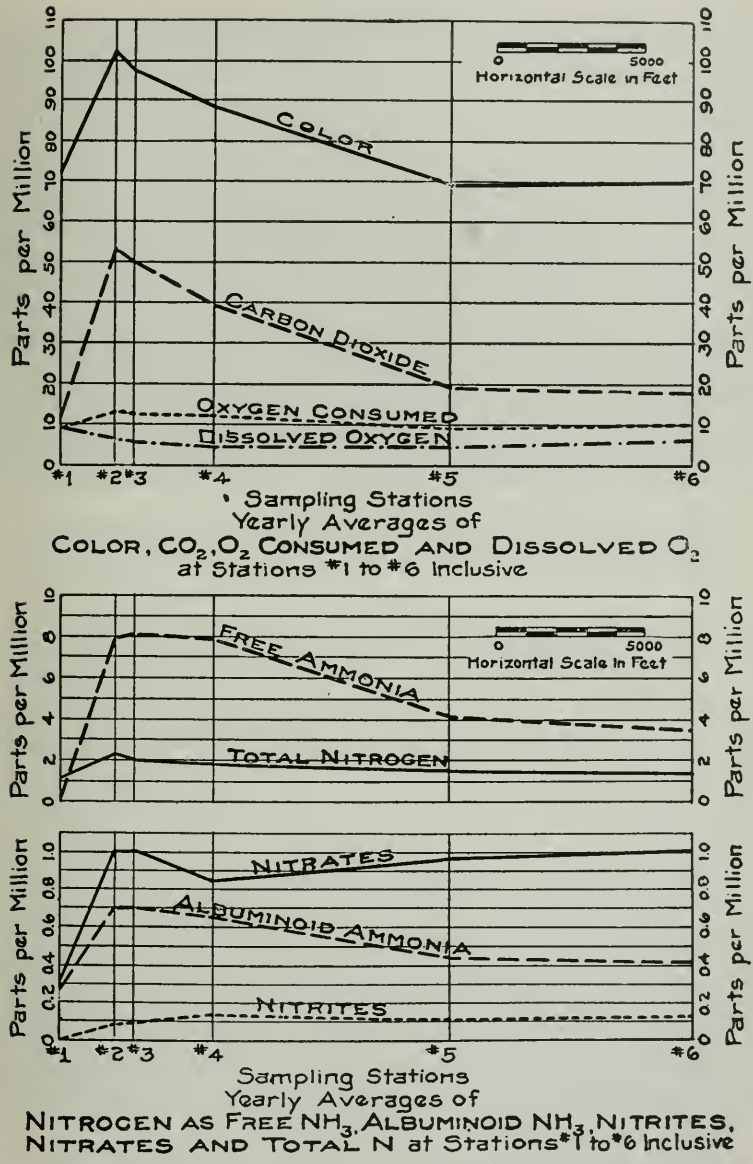


Fig. 42.—Diagram showing the condition of the stream studied at Brockton. The chart shows the average figures obtained from weekly analyses of the water at each sampling station covering a full year.

are used as food by protozoa which are found in great numbers just below the place where the bacteria are most numerous. The protozoa in turn are devoured by small crustacea and other higher animals, which are suitable food for fish. The abundance of the carbon dioxide and nitrates is removed by simple and higher plants which grow in such a quantity as to almost clog the stream and furnish protective habitations for the millions of tiny animals which nature is using in the purification process.

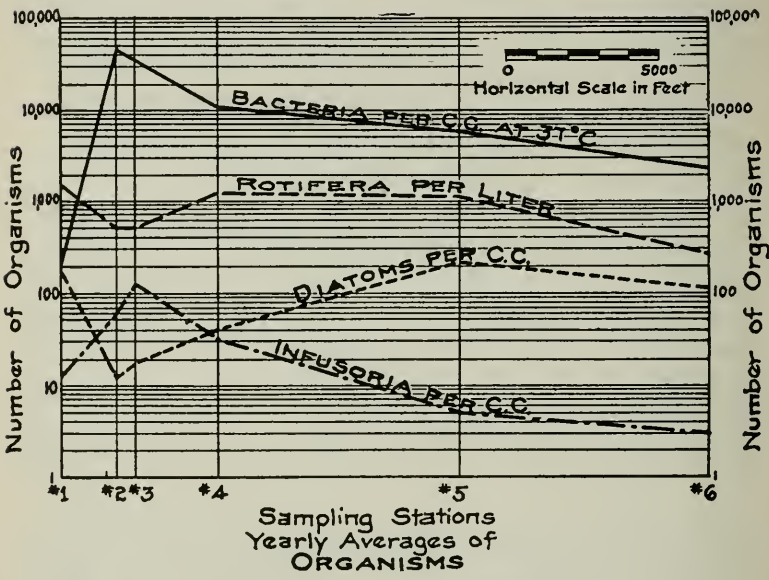


Fig. 43.—Diagram showing the abundance of microorganisms at the various sampling stations.

The accompanying diagram shows the effect upon the stream produced by introducing the sewage effluent, which came in between sampling stations No. 1 and No. 2. The other sampling stations indicated in the diagram are approximately the following distances below station No. 2: No. (3), 980 feet, No. (3a), 2000 feet, No. (4), 3650 feet, No. (5), 11,580 feet, No. (6), 19,700 feet.

Fig. 44.—This view of the stream taken near Sampling Station No. 4, in midsummer shows how completely the higher aquatic plants fill this part of the stream at this season. These plants strain out the suspended matter and prevent the smaller plants and animals from being carried down-stream.

Fig. 45.—A corresponding view in midwinter, showing how differently the same region appears under winter conditions and high-stream flow. The biological processes of purification are greatly reduced. There is greater dilution but less purification.

The storage of water is a simple method of purification and is inexpensive except where there may be a high cost for reservoir construction. Experiments indicate that all the disease germs usually die out in water which has been stored for a month. In reservoirs and in relatively pure waters the biological activities are not as intense as in heavily polluted water and most of the bacteria are settled out on the bottom or die for want of food.

Filtration.—There are two types of filtration for drinking water, slow sand filtration and rapid sand filtration. In the construction of a *slow sand filter* a concrete floor is first laid down and drains with open joints are laid along this impervious bottom, the joints being covered with small rocks. Then the whole filter bottom is covered with gravel to a depth of several inches and on top of the gravel there is a layer of sand about 3 feet in depth. In cold climates the whole structure is placed low in the ground and roofed over with a concrete roof which is covered with soil. This is necessary to prevent the surface from freezing up during the winter months. The rate of filtration is 2½ to 5 million gallons per acre per day.

Such a filter, as the one at Washington, D. C., is made up of large units of about one acre each in area. The water is run onto the sand to a depth of 3 or 4 feet and filters rapidly. One acre of filter surface is capable of filtering about three million gallons of water per day. This process will remove 99 per cent of the bacteria and suspended particles and will reduce the color 30 per cent. A description of the biological principles of the slow sand filtration will be found in the chapter on Waste Disposal.

The *rapid sand filter* or "mechanical filter" or "American Filter" as it is sometimes called, is designed to accomplish the purification process with much less sand area. In this process a coagulant is first added to the water to produce a chemical precipitate. The substances commonly used are lime and alum which react to produce aluminum hydroxide.

These chemicals are thoroughly mixed with the water which is then passed through a storage tank where the precipitate settles out carrying down with it many of the bacteria and much of the dirt suspended in the water.

From the top of this tank the water is drawn off to the filter, which in principle of construction, is similar to the slow sand filter except that it is much smaller in area and is enclosed in a sort of concrete bin. This filter is also supplied with devices which make it possible to wash the surface of the sand by forcing water back up through the filter. This washing process must be carried out frequently as the coagulant collects on the top of the sand and clogs the filter. The bacterial efficiency is about 98 per cent or 99 per cent and it operates at the rate of 125 million gallons of water per acre per day.

Chlorination is the third important method of purifying water. Chlorine is added either in the form of chloride of lime or as chlorine gas liberated from tubes of liquid chlorine. Various chlorinating devices are on the market. In whatever form the chlorine is used enough must be added to kill the nonspore-bearing bacteria and care must be taken to avoid adding so much as to give a disagreeable taste to the water.

Sometimes complaints are heard because of chlorine tastes in water but the careful operation of chlorine plants should make it possible to avoid serious difficulty in this matter. Not very long ago the writer investigated the water supply of a small town. The water was taken directly from the river and although chlorination had been going on for nearly a year I was informed by the Chairman of the Local Board of Health and other citizens that nothing whatever was being done to purify the water. Apparently there were no disagreeable tastes in this instance. At about the same time a quite different incident came to my attention at another town. It was generally known that chlorine was about to be used in the water although the exact time when treatment would begin was not known. Complaints of its disagreeable taste reached

the health officer two days before any chlorine whatever was used.

When the taste of chlorine does occur it is disagreeable but sometimes at least complaints are more imaginary than real. The amount of chlorine necessary to disinfect a water depends upon the amount of organic matter present. Proper methods of chlorination render the water practically free from non-spore-bearing bacteria.

Emergency Treatment of Drinking Water.—It occasionally happens that the traveler or camper must use drinking water of doubtful quality. The simplest expedient for killing infectious bacteria is to boil the water. Many people dislike the taste of boiled water especially if it cannot be made cold after boiling. It may be used in making tea or some other hot beverage which has a distinctive flavor.

Still less frequently it happens that the traveler or hunter must partake of water which is likely to be impure when there is no opportunity to boil it. There are special chlorine-containing tablets on the market for use in disinfecting small quantities of water. The same results may be obtained by using bleaching powder or chlorinated lime. A teaspoonful of bleaching powder containing 35 per cent available chlorine is added to a pint of water, stirred and then allowed to settle. The clear fluid may be used as a stock solution for purifying drinking water. Nine drops to the quart of water or a teaspoonful to the gallon is the amount usually recommended. The amount of chlorine needed depends largely upon the amount of organic matter in the water, and the amount of free chlorine in chlorine-containing substances is likely to vary if these substances are not kept under proper conditions so that no method for chlorine treatment for small quantities of water is as simple, safe and sure an expedient as boiling.

CHAPTER XIV

WASTE DISPOSAL

Sanitary engineering is a science by itself. But there are certain facts and important principles involved in waste disposal which any person might well know. We shall first describe some of the principles involved in the purification of sewage and the disposal of wastes, and then discuss some of the problems in waste disposal for a rural community or for a residence, because it often happens that those who are not sanitary engineers like to know about the methods applicable at a camp, a cottage or an institution in which they may be interested. By waste disposal we mean the disposal of sewage and garbage.

SEWAGE DISPOSAL

Sewage is the material discharged into the sewers of a city or community and should not be confused with the word sewerage which has to do with the sewer pipes themselves. Sewage is the material and sewerage the piping system which carries the sewage.

Our consideration will be directed mainly to domestic or household sewage, which consists chiefly of excreta mixed with the sink wastes, and other waste waters going from the house. In city sewage there are also street washings and manufacturing wastes.

It is unnecessary to dwell upon the importance of proper sewage disposal. In a previous chapter we have seen that lack of care in disposing of sewage from houses where there are cases of intestinal disease may result in serious epidemics. The organisms of such intestinal diseases as typhoid, cholera, dysentery, and paratyphoid are discharged in innumerable quantity in the feces of the patient and may remain alive for many days, for weeks even. And wherever drinking

water, milk or food becomes contaminated with the excreta from these patients there is a possibility of spreading the disease. So that the first and most important problem in sewage disposal is to take such care of excreta that there will be no opportunity for spreading infection. But we must not only take care of sewage in such a way that germs will be killed but also in such a way that it will not produce a nuisance in the community. The problem of proper waste disposal is not a simple one.

In considering disposal we need to know the composition of sewage. The most important constituent of domestic sewage is the protein and other organic material of the excreta. Human excrement is composed largely of bacteria together with undigestible products like cellulose and the secretions of the mucous lining of the digestive tract, the bile salts and special substances like inorganic compounds. Most of this material is protein and carbohydrate, with a small amount of fat.

Direct Disposal.—Sewage may be disposed of either directly or by purification. In cities located on the seashore or on great rivers and lakes disposal by dilution or the direct discharge of sewage into a large body of water is possible. A stream can purify about one-fiftieth of its own volume of raw sewage. In the woods or on farms excreta may be covered with soil. But in the interior of the country where the population is becoming more dense and where all the streams are used as drinking water supplies some other method of purification must be resorted to.

Chemical Purification.—Artificial methods of sewage disposal are by either chemical or bacteriological purification. By chemical purification we mean adding some chemical like a strong alkali or acid or chlorinated lime to the sewage in order to disinfect it.

The two processes which have been advocated for the purification of city sewage by the chemical means are (1)

precipitation of sewage sludge with lime and alum, and (2) the Miles process of disinfection by means of sulphurous acid produced by burning sulphur and liberating the sulphur dioxide (SO_2) into the sewage. Neither of these processes is in use to any extent at the present time and the only chemical purification method of sufficient importance to

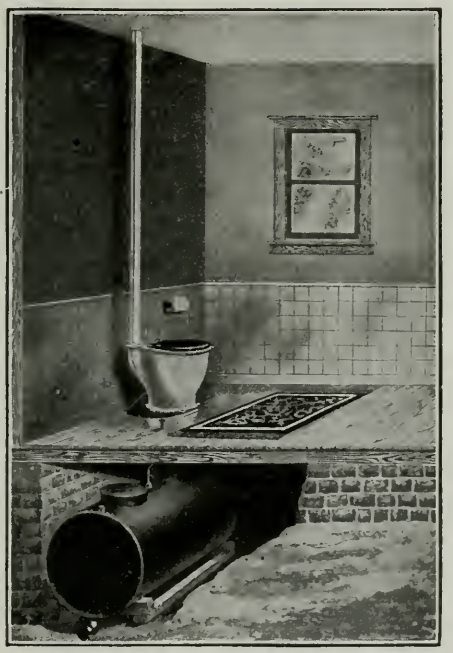


Fig. 46.—A Chemical Closet installed in a home where running water is not available. (Courtesy of the Dail Steel Products Company, Lansing, Mich.)

deserve description in a general text is the use of the chemical closet in isolated homes or in camps.

The Chemical Closet in its simplest form may be used inside the house. It consists of a jar or an iron tank placed under a toilet seat and containing a strong solution of caustic soda which disinfects and partly dissolves the excreta which reach the liquid. These closets are nearly free from odor.

They are made by dozens of manufacturers in America and may be obtained either as a single unit consisting of a single seat or as a large unit consisting of several seats over the tank. Such installations are now used in many boys' camps and in hunting camps.

Bacteriological Purification.—There are two widely different processes for the bacteriological purification of sewage, the ærobic and the anærobic. It is the presence or absence of oxygen that determines which of these two processes will take place.

Ærobic Processes.—The biological principles of ærobic purification have already been alluded to in our reference to the nitrogen cycle in the discussion of the interpretations of the chemical water analysis. When enough oxygen is supplied to sewage, as it is being broken down by the bacteria contained within it, much of the nitrogen is finally converted into nitrates through the various descending steps of the nitrogen cycle. Carbon dioxide is also produced in large quantities. When the process is completed the solid residue of the sewage (sludge) has somewhat the consistency of humus soil. Practical applications of this principle are found in Sewage Farming, Intermittent Sand Filtration, Rock Filters and Æration.

1. Sewage Farming.—It has long been known that it is possible to purify sewage by allowing it to flow onto soil which is largely sand or gravel. This is merely the utilization of the agricultural process of fertilizing land. Near Paris many acres of sewage farms have been in operation since 1866. Farmers buy sewage from the city securing thereby both water and fertilizer. Gates and ditches are built in such a way that the flow of sewage may be directed to the desired section of the farm. There are smaller sewage farms in Europe much older than those in Paris.

The purification of sewage by this method is almost complete for the solids are left upon the surface and the water,

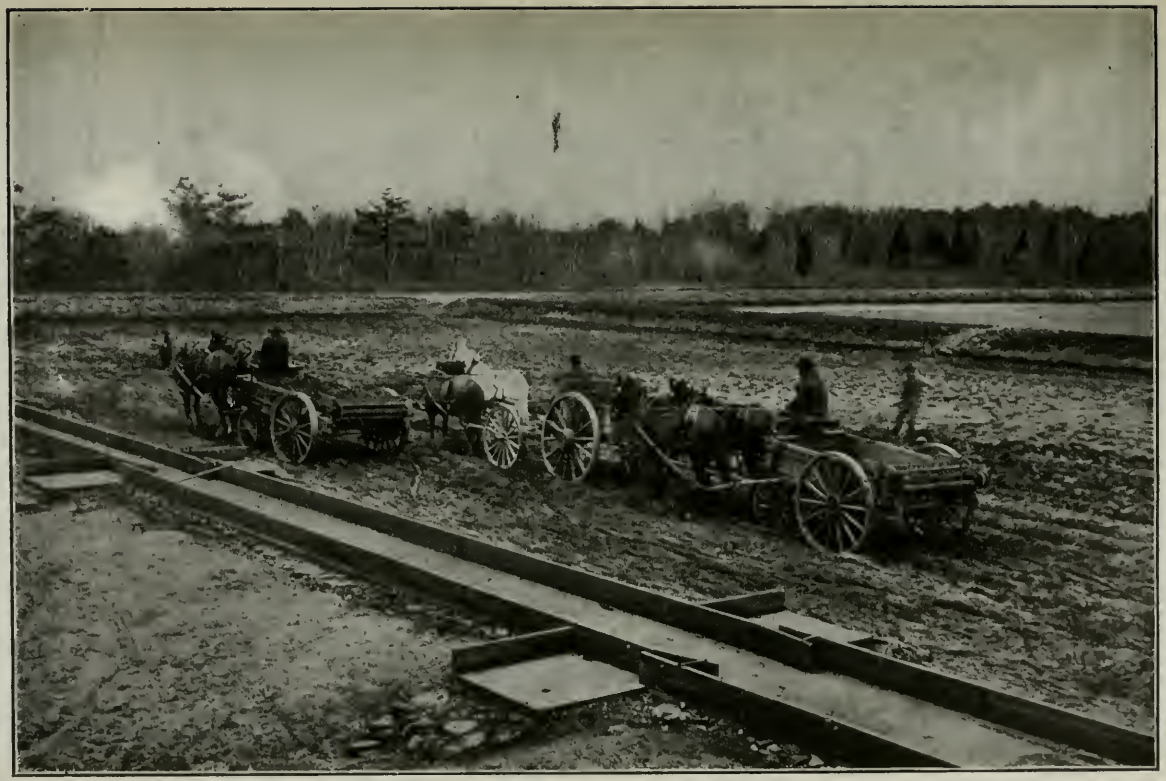


Fig. 47.—Removing the sludge from the sand beds at the Brockton Sewage Purification Works.

which soaks through the soil and finally makes its way to the streams, lakes or rivers, shows little trace of pollution. But in order that sewage farming shall be a success the soil must be mainly sand or gravel and free from clay, peat and chalk. Moreover a great deal of land is required since in American cities about an acre of land is necessary to treat the sewage of 100 people. The rate of filtration on the sewage farms near Paris is 12,000 gallons per acre per day. There are a few sewage farms in California where soil and climate are favorable, but for the most part American cities use more intensive methods of sewage disposal.

2. Intermittent Sand Filtration.—Although earlier and limited laboratory studies had been made in England, the principle of the purification of sewage by filtration through sand was largely developed at the Massachusetts Sewage Experiment Station, at Lawrence, between 1886 and 1890. In these experiments sewage was filtered through several feet of sand which had been placed in large round wooden tanks. These experiments, which first combined biological, chemical and engineering research in behalf of the State and in the interest of the public health, form an important and interesting chapter in the history of sanitary progress.

Sand beds as they are now constructed are usually about one acre in area and from 4 to 5 feet deep. In making such a bed underdrains of tile with open joints are first laid. The joints are protected with rocks and gravel to prevent the drain from becoming clogged. Then coarse sand is placed over the drain to a depth of 2 or 3 feet and fine sand is used for making the top of the filter. The bed is flooded with sewage to a depth of a few inches and then allowed to dry after which a "breathing space" of several hours is allowed before a second dose of sewage is put on the bed.

The reason for this intermittent method of dosing the sand bed becomes apparent upon a consideration of the biological principles involved. It is found that as the bed is used the sand grains near the surface become coated with a gelatinous

growth of the oxidizing bacteria to which the sewage purification is due. This gelatinous coating of the sand grains makes the filter more tight and as the coating becomes heavier with increased numbers of bacteria the efficiency of the filter rapidly increases. These are ærobic or oxygen breathing bacteria and it is therefore necessary to let the filter rest or "breathe" long enough for oxygen to penetrate into the bed between the times when the bed is flooded with sewage.

A good intermittent sand filter will remove 99 per cent of the bacteria of sewage and effect a very high degree of purification. In fact the effluent from such a filter is almost a "drinking water" effluent. A filter bed one acre in area will treat from fifty thousand to one hundred thousand gallons of sewage per day. In other words one acre of filter will provide sewage treatment facilities for about six hundred people.

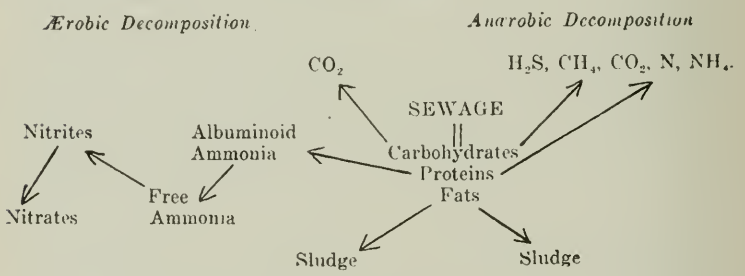
3. Sprinkling Filters.—Sprinkling or percolating filters treat sewage much more rapidly than intermittent sand filters. They make use of the same biological principle of ærobic bacterial action but the purification which such filters effect is not as complete as in the case of the sand filter. They are from 6 to 8 feet deep and are composed of broken stone, coal or coke with an effective size of from 1 to 3 inches. This broken stone is placed upon a concrete floor which is properly drained. The sewage is thrown onto the bed through sprinkler nozzles which spray the sewage into the air in much the same way that water is thrown into the air by a lawn sprayer. This allows the sewage to accumulate oxygen from the air and it is also continuously in contact with the air as it trickles over the rocks of the porous filter.

Filters of this type properly constructed and operated may be depended upon to remove from 70 per cent to 90 per cent of the bacteria and to produce a non-putrescible liquid effluent. This effluent however contains suspended solids which are easily settled out and which are putrescible. The average

rate of filtration in American filters of this type is about two million gallons per acre per day.

4. Activated Sludge.—A more recent development in the treatment of sewage by the ærobic process involves bubbling air through the sewage as it passes through a deep tank. A few inches above the real bottom of such a tank there is a false bottom, which contains many square plates of porous tile. Air is forced through these plates in fine bubbles which make their way through the sewage to the top of the tank. By continually forcing air through the sewage the small particles of sludge soon become "activated" by the accumulation of mineralizing bacteria so that the rate of nitrate formation becomes exceedingly rapid.

THE BACTERIAL ACTION IN THE ÆROBIC AND ANÆROBIC PROCESSES



A bacterial removal from 80 per cent to 90 per cent is claimed for the process, a liquid effluent of high quality is obtained and the sludge is nonputrescible and of good fertilizer value.

Anærobic Processes.—The anærobic decomposition of sewage which takes place whenever sewage is stored in large tanks is quite a different process. Under these conditions the available oxygen is soon used up by the ærobic or free-oxygen breathing bacteria. Such bacteria soon die for want of oxygen and there remains only the anærobic bacteria: those which are able to wrest their oxygen from the organic compounds

undergoing septic action. From such a process three gases are produced from the proteins, namely, nitrogen gas, ammonia, and hydrogen sulphide. From the carbohydrates some carbon dioxide and a greater quantity of marsh gas are produced. This process results in the reduction of the quantity of solids but leaves a residue or sludge which is tarry in consistency and appearance and is further putrescible. The above chart contrasts the anærobic and ærobic processes.

1. The Cesspool.—A familiar example of the anærobic purification of sewage is the leaching cesspool which is usually built like a well with sides made of large stones between which the water may pass into the surrounding soil. The sewage solids accumulate at the bottom of this tank and are greatly reduced in volume by the septic action of bacteria.

2. The Septic Tank.—Sometimes a tank with tight cement walls is used instead of the leaching cesspool and here there is an even better opportunity for anærobic action to take place. Here as in the old style cesspool the quantity of solids is greatly reduced but residue must be occasionally removed. The liquid is drawn off from near the top of the tank to be further purified or discharged into some body of water.

3. The Two-story Tank.—More recently this simple tank has been improved upon and we have had what we call the two-story tank of which perhaps the most important type is that known as the Imhoff Tank. The sewage flows slowly through the upper chamber and the solids settle to the bottom and pass through the narrow slot into the lower or sludge digestion chamber. It is in the lower chamber that the septic process takes place and there is an advantage over the single story tank in that the gases produced are prevented from passing through the fresh sewage. The result is that the effluent of such a tank has been freed from solids without losing its dissolved oxygen and it is therefore more easily purified further by filtration or dilution. The sludge digests for sev-

eral weeks in the lower chamber and is finally pumped out, allowed to dry and is disposed of on waste or agricultural land.

Final Disinfection.—Chlorine disinfection is frequently used in municipal plants, discharging the effluent into a run-

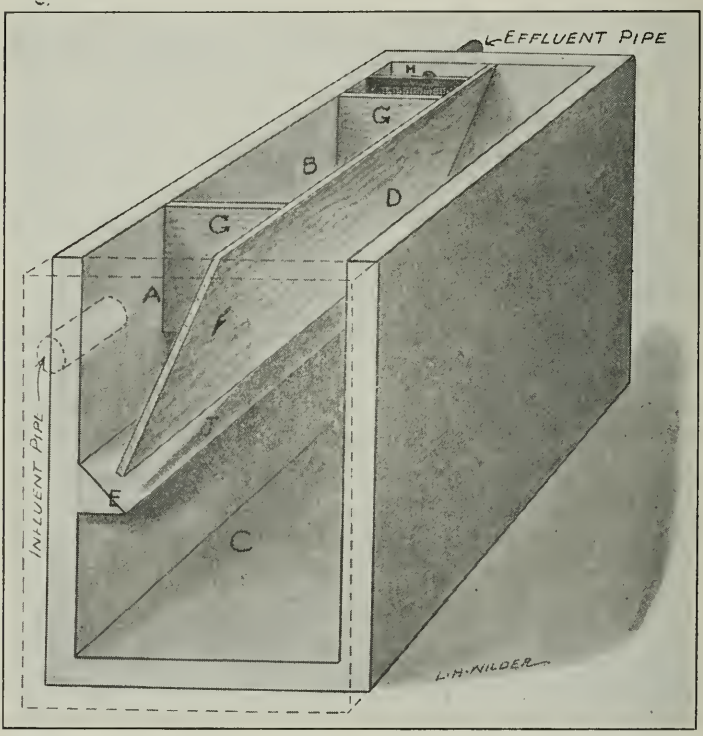


Fig. 48.—Imhoff Tank. The water flows through the upper chambers of the tank *A* and *B*, the flow being reduced by the baffles *G;* the upper chamber is separated from the lower or sludge digestion chamber *C*, by the partition *F;* the solids settle out through the slot *J*, and the gases escape to the right *D*, being separated from the fresh sewage. *E* is a baffle, *H* is a screen. (Public Health Bulletin, No. 101.)

ning stream. The reason for this is that there can be no absolute certainty that the various processes of sewage disposal will eliminate all disease bacteria. In some cases calcium hyperchloride is used as a disinfectant. Where there

is a separate sewage disposal installation for institutions, such as hospitals, continuous disinfection of the effluent is commonly recommended by sanitary engineers.

Possibilities and Limitations of Sewage Purification.— The above illustrations are intended only to further explain the principle of sewage purification. In actual practice two or more of these processes may be used jointly and other devices like grit chambers to remove the sand, and fine or coarse screens to remove part of the solids may be added. The sewage of a city might pass successively through screens, septic tanks and a trickling filter, after which the effluent might be disinfected with chlorine before being allowed to flow into a lake or stream. The sanitary engineer must prescribe a treatment in each case which is adapted to the sewage itself and to the condition and location of the city.

A good example of purification may be found at the city of Brockton, Mass. Brockton is an inland city of about 65,000 population which is not located on or near any large lake, or river. The sewage is purified by sprinkling filters and then by slow sand filtration, after which the effluent is carried into a small brook. The average daily flow of this brook in summer is only a half million gallons per day, but so completely is the sewage purified that two million gallons of sewage effluent are received daily by the little brook without producing a nuisance. Moreover, studies upon the self-purification of this stream referred to in a previous chapter show that the final processes of purification are carried out so swiftly by the innumerable plants and animals of the "food cycle" referred to that two miles below the point where the sewage effluent enters, the stream has regained its normal appearance.

It is possible to purify sewage and discharge the effluent into a stream which is soon to be used again as a city water supply provided the second city adopts proper methods of purification for its drinking water. But there is danger that we may go too far in this direction. No one likes to feel that he is drinking purified sewage even though the purification

TABLE OF SEWAGE PURIFICATION METHODS

Type of Treatment	*Cost of maintenance*	*Rate of Treatment (or time*	*Construction material*	*Method of Treatment*	*Bacterial Removal*	*Removal of Suspended Matter*	*Removal of Organic Matter*	*Sludge*	*Effluent*	*Present Use*
Screening	Wide variables		Steel or Copper	Continuous	0-20%	30-50%	10%	Putrid	Putrescible	Not General
Chemical Precipitation	$5 to $9 per m.g.	4 to 6 hr period	Concrete Tanks	Precipitation	85%	75%	25-50%	Putrid and "Salvy"	Poor	Limited
Sewage Farms	$6-10 per m.g.	2,000 to 15,000 g.a.d.	Gravel Soil	Intermittent Flooding	99%	100%	100%	Porous	Excellent Non-Putrescible	Limited
Intermittent Sand Filtration	$10 per m.g. or $5(to $400 pe a. per yr	60,000 g.a.d	4-6 ft. of Sand 0.2 to 0.5 mm.	Intermittent Dosing	99%	98%	95%	Porous	Excellent Non-Putrescible	Common
Sprinkling Filters	$2 to $5 per m.g.	0.5 to 2 m.g.a.d.	5 to 8 ft. of 1.5" Stone	Intermittent Sprinkling	70-90%	0-36%	50-70%	Putrescible	Putrescible	Common
Activated Sludge	—	—	Tanks and Filtross Plates	Air-Continuous or Intermittent	80-90%	80%	80%	Stable	Excellent	Increasing
Septic Tank	$6 m.g.	6-24 hrs.	Concrete Tanks	Anaerobic Storage	65%	65%	30%	Tarry	Offensive	Limited
Imnoff Tank	$4 m.g.	3 hrs.	Concrete Tanks	Anaerobic Storage	65%	65%	30%	Tarry	Putrescible	General
Miles Process	—	—	Tank and Sulphur Burner	Acid	99%	80%	80%	Non-Stable	Sterile Acid	Experimental

g. a. d = gallons per acre per day; m. g. d. = million gallons per day.

process is complete and the pollution fairly remote. Furthermore, in such a case there is the possibility of a slip in the purification process and the consequent contamination of the drinking water supply. If such a process of purification is necessary it is certainly much better to have sand filters between the sewage and the water supply than to rely upon other methods of purification or disinfection. A table has been added indicating some of the facts of construction and operation for the more important methods of sewage purification.

Rural Sanitation.—The importance and difficulty in securing satisfactory and safe disposal of waste material in rural

Fig. 49.—Sewage purification plant at Atlanta, Ga. In the foreground there are grit chambers in which the sand is settled out. The water then flows into the large Imhoff Tanks beyond and from these tanks the effluent is carried to trickling filters some of which are seen in action. At the extreme left a sand bed for drying the sludge appears in indistinct outline.

areas are expressed in the fact that the death rate for typhoid fever is much higher in the country than in the city. The city has a municipal water supply and a sewage disposal system both of which are under the supervision of expert sanitary engineers. In the country each family has its own source of water and its own method of waste disposal.

The disposal of human excreta must be so safeguarded that water and ice supplies will be protected from pollution. Milk, small fruits, and vegetables must be safeguarded from contamination. Flies, vermin, and domestic animals are capable of spreading infectious material, and must be kept

away from all manner of excrement. The frequency with which these precautions have been neglected is shown by the figures from Dressler's survey of fifteen hundred rural schools in 1922. This report stated that 60 per cent had unsafe drinking water, and only 1 per cent had sanitary toilets.

The farmer is not the only person who is confronted with the problem of providing safe sanitary toilets with suitable privacy and freedom from disagreeable odors. The city dweller who owns a country estate, a summer cottage, hunting lodge, or camp, faces the same difficulties.

The general principles which have been discussed above remain the same for all types of disposal. The three most practicable methods of dry disposal are the pit privy, the receptacle privy, and the chemical closet. Wet disposal methods include the use of the cesspool, the septic tank, the Imhoff tank, and subsurface irrigation.

The pit privy is the simplest arrangement which meets the requirements of sanitation and privacy. It may be used at farms, camps, or hunting lodges if it is remote from the water supply sources. In such a case the pit may be left pervious but the superstructure may be moved from time to time to a new location which has been prepared in advance and the original pit filled in with earth. The previous pit should never be used in villages or where contamination of water is possible. In such locations the vaults may be given an impervious lining and the structure thereby made more permanent in character. Particular care must be taken to prevent the transmission of bacteria by flies and animals.

The essential elements of a proper pit privy include a pit of proper depth and capacity, a tight superstructure so designed as to prevent the passage of flies to or from the pit, a floor above the ground level, a door, lids that close automatically when not in use, and durable screens over all openings for ventilation. Waste, other than excreta, should be excluded from the pit or vault.

The receptacle privy has a can, pail, box, or tray substituted for the pit or vault. It can be placed indoors or it may be used as an outhouse. In either case it requires frequent removal of waste and constant supervision. The receptacle usually has a capacity of about two cubic feet. It must be removed at least once a week in warm weather or when about

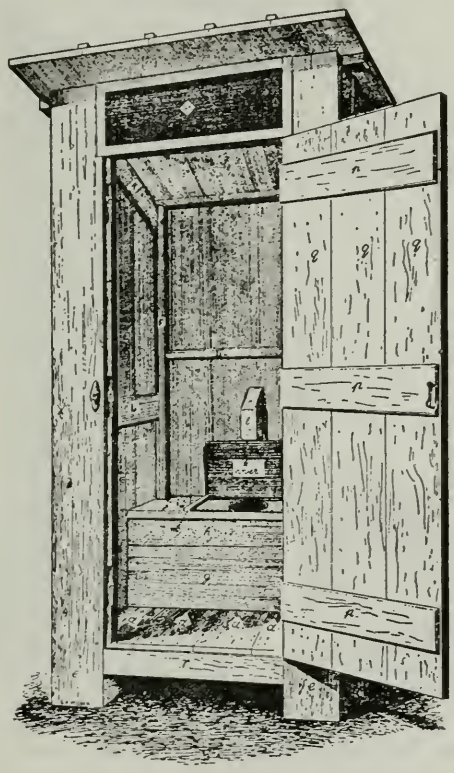


Fig. 50.—A single-seated sanitary privy. Front view. (After Stiles.)

two-thirds full, and be replaced by a clean receptacle having an inch or so of sawdust or dry earth on the bottom. It may be handled from inside or from the rear of the privy house. In order to prevent access of flies it should be fly-tight, and fitted directly under the seat.

The chemical closet has already been described.

The cesspool which has already been described is probably the most common device for wet disposal. The *septic tank* is simple to use and is always to be preferred where there is

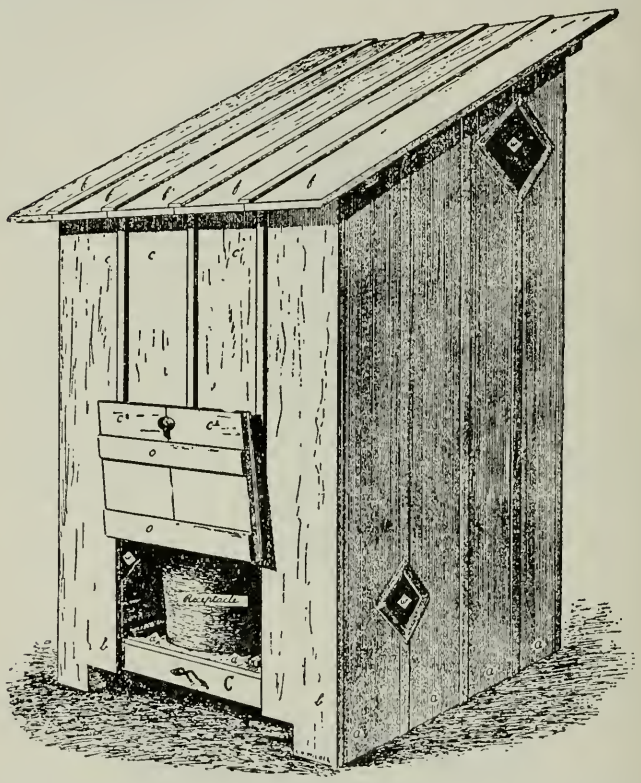


Fig. 51.—Rear view of privy shown in Fig. 50. (After Stiles.)

any danger of infecting a water supply, as by seepage from a leaky cesspool. The more elaborate construction of the *Imhoff tank* is sometimes found in larger institutions, such as schools, hospitals, or hotels, which are not accessible to a sewerage system. The use of specially designed septic tanks or Imhoff tanks of suitable size for a single dwelling is

being urged by many State Departments of Health. *Trickling filters* or *sand filters* are sometimes installed for large houses or institutions, but they require the services of an expert in design and operation.

Subsurface irrigation is a method of disposal which has not been mentioned heretofore. It is an ingenious device consisting of lines of open-joined tiles laid from 8 to 15 inches below the surface of the soil. This may be the best method to employ, provided the soil is not water-soaked or too impervious. Sometimes the former difficulty is overcome by embedding the tile in a light fill of sandy soil. The irrigated area should be not less than one hundred and fifty feet from any habitation.

The sewage passes through a grease cup at the house and then into a tank from which it is delivered intermittently from three to six times a day by means of a siphon which is usually installed in a dosing chamber. The sewage has an appreciable storage time in the tank, then passes over into the dosing chamber from which it is discharged into the tile, soaking into the ground through the open joints. The tile is usually three or four inches in diameter. It is laid with a gradient of two to six inches per hundred feet, and its open joints are covered with tarred paper. During times of storm the soil is so completely saturated with water as to make ready disposal difficult. Because of this and because of the difficulty of getting uniform distribution, subsurface irrigation is not usually recommended where other methods of disposal are feasible.

Excellent pamphlets dealing with rural sanitation may be secured from State Health Departments.

Disposal of Garbage.—Kitchen waste should be collected in metal cans having tight covers, and should be kept free from ashes and other material. The can should be emptied often and scrubbed with hot water and soap. Its care will be greatly facilitated if it is kept lined with several thicknesses of old newspapers. While small amounts of garbage

may be easily burned up in the kitchen range, there is risk of odor. It may be buried in the soil. Sometimes garbage from small communities is collected by a farmer who plows it into the soil for its fertilizer value.

Incineration is sometimes practiced by constructing a special pit perhaps two and a half by five feet, with the

Fig. 52.—Outdoor incinerator (Arnold type). (Gardner.)

bottom sloping from a depth of six inches at one end to twelve inches at the other. Such a trench is filled with field stone or with cans and bottles, and the excavated earth is banked along the sides. A fire is built on top of this pit and, after the stones are thoroughly heated, the liquid waste is poured into the trench at its shallow end where it is gradually evaporated. The solid material is placed on top where it dries and finally burns up. A certain amount of odor is inevitable.

Probably the most economical method of garbage disposal for the farmer or for small towns is in feeding it to hogs. Some large cities incinerate garbage along with rubbish. Another process involves the cooking of garbage with some

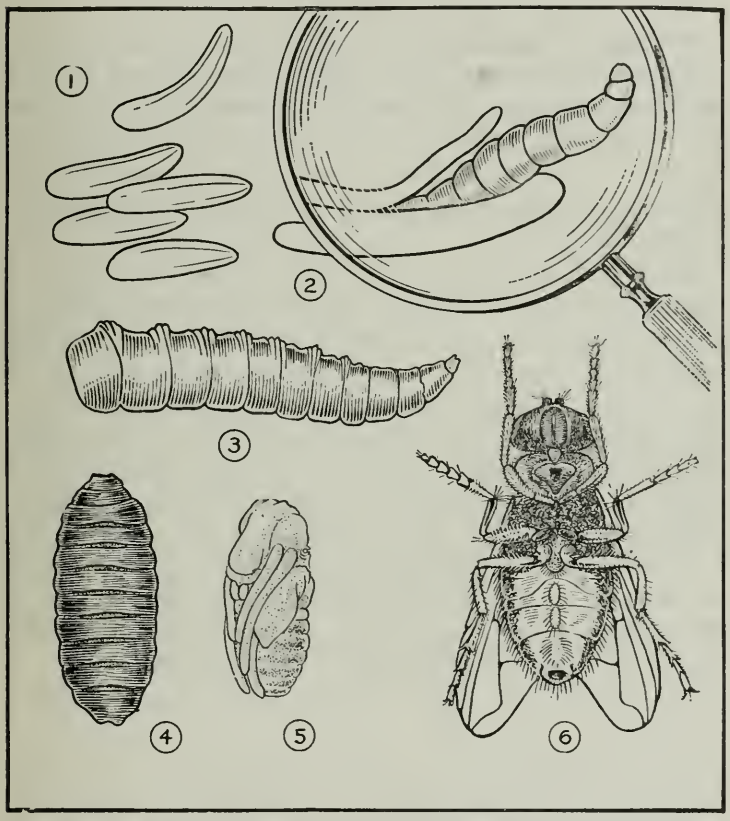


Fig. 53.—Life history of the house fly. *1*, Eggs of the house fly; *2*, larva or maggot hatching from the egg; *3*, larva; *4*, pupa in case; *5*, nearly developed pupa; *6*, mature house fly as seen walking up the outside of a window pane. (From Turner and Collins: *Community Health*, D. C. Heath & Co.)

grease solvent. The cooking process separates an appreciable amount of grease which is later recovered by evaporation of the solvent. The grease is sold as a basis for the

manufacture of low grade soap. The tankage or material left in the tank at the end of the cooking process has some value as a fertilizer base, and the proceeds from these two products return an appreciable part of the cost of operating the disposal plant.

Disposal of Manure.—The chief sanitary difficulty involved in maintaining a barn or stable arises from the fact that cow and horse manures offer favorite breeding places for the common house fly. It takes about two weeks for the larvae to develop. This means that the manure must be disposed of within that period or definite steps taken to destroy the larvae.

Fly breeding may be prevented by the application of about one pound of borax to sixteen cubic feet of manure. This is the best larvacide to use if the manure is to be used later for fertilizer. Very satisfactory results may be obtained by sprinkling the manure with a solution of two pounds of copperas to a gallon of water, or with a solution of hellebore mixed in the proportion of one pound to twenty gallons of water and applied at the rate of a gallon of the solution to each cubic foot of manure. Fly breeding may be prevented to a considerable extent by battening down the exposed surface of the manure with a spade. Many of the larvae are then destroyed by the heat generated below the surface during the process of decomposition.

CHAPTER XV

PUBLIC HEALTH ADMINISTRATION

The health of the individual is protected, first, by proper personal hygiene, and second, by the activities of organized government in disease prevention. We are here considering the health administration of the Federal, State and local governments.

Public Health Authority.—The division of the responsibilities for administering public health among National, State, and Municipal governments is dependent upon the relationship which these bodies bear to each other under the Constitution of the United States and the various State constitutions. Ours is a Federal government and each State has supreme power in those questions which affect that State alone. In such matters it may, if it chooses, direct the individual community and it may not be interfered with by the Federal Government. In considering the activities of the public health officials we shall first investigate their powers under the law and then discuss their activities.

FEDERAL PUBLIC HEALTH FUNCTIONS

The National Government has only such powers as are granted to it by the Constitution. In such matters State law must give way but where power is not specifically given to the National Government it is assumed that the power lies with the states. There is no specific mention of any power over the public health in our Federal Constitution but authority is granted "to make all laws necessary and proper for carrying into execution any of the powers placed by the Constitution in the Government of the United States or in any department or officer thereof." And "power to regulate commerce, levy and collect taxes and carry out treaty agree-

ments'' are specifically granted to the National Government. Certain public health activities are very properly carried on under these broad powers.

The Power to Regulate Commerce.—The first general clause by which the Federal Government has power to regulate public health is the clause giving it power to regulate commerce with foreign countries and among the several states. The words ''commerce'' and ''regulate'' are not defined and their meaning has been gradually enlarged. *Commerce* is interpreted to include not only the active transportation of persons and things from one place to another but also artificial land and water routes, terminals, harbors, vehicles, and the persons, both carriers and shippers, consignees, employers and employed, who are engaged in the active transportation. Commerce embraces purchases and sales and the negotiations entered into in order to lead to sales. Indeed there is a tendency to regard manufacturing as a part of commerce where its regulation is necessary to the effective regulation of what is admittedly commerce.

The power to *regulate* includes not only the right to charter companies and the right to regulate contracts between shippers and carriers, carriers and their employees, between sellers and purchasers, but also the right to prohibit commerce on certain articles, to prohibit certain methods of carrying on commerce and to license those engaged in commerce.

The power of the government through this clause is the power to prohibit, under criminal penalty, the interstate transportation of persons or articles. It includes, therefore, the power of quarantine against persons or things to prevent their entrance from one state to another where such an entry may be judged to endanger the public safety. In commerce with foreign countries the government may take action in the nature of either an embargo or an inspection.

The power of the government to restrict the transportation of an article includes the power to determine whether the

article transported falls within the prohibited class and thus provision is made requiring the labeling of articles and the inspection at the place of manufacture of articles intended for interstate transportation as well as for the licensing of persons engaged in their manufacture.

An important use of this power was the enactment of the Food and Drug Law which forbids the transportation from one state to another of adulterated food products and drugs. The law was upheld by the Supreme Court as constitutional. On the other hand, the Child Labor Law which forbade the transportation of goods made in factories where children under 14 years of age were employed, or where there were employed children under 16 years of age who worked more than eight hours a day was not upheld by the Supreme Court. It was declared unconstitutional because it was regarded as an attempt to regulate the methods of manufacture within a state. The transportation of articles manufactured by child labor could not in the nature of things be harmful and therefore the injury to health which resulted was done in the state of manufacture and hence was due to manufacturing and not to commerce.

Taxation.—The second source of power in regulating public health is the power to "lay and collect taxes, duties, imposts, and excises to pay the debts and provide for the common defense and general welfare of the United States." The power to tax is in reality the power to destroy. Congress has in the taxing power a method of protecting public health which naturally lends itself to matters where prohibition rather than regulation is sought. The only limit to this power is the condition that the classification of articles and persons to be taxed must have some reasonable relation to the object sought.

In a second attempt to eliminate child labor Congress passed a law placing a prohibitive tax on all goods made in factories where children were employed. This law also was declared unconstitutional because in the judgment of the

supreme court it was clearly an attempt to regulate manufacture and this use of the taxing power was not intended by the Constitution. It, therefore, became apparent that the Constitution of the United States must be amended if we were to secure prohibition of child labor through Federal legislation.

Another example of the taxing power in the interest of public health is the Harrison Act, which regulates the use of drugs by exercising the taxing power.

Defense and Welfare Powers.—The power to "provide for the common defense and general welfare of the United States" is also important. Under this power the government has established a national Public Health Service authorized to assist state health authorities and cooperate with them. Thus, although the United States Government may not interfere with the sanitary work of the states it may have a far-reaching influence on state health administration through its power of appropriating money for health work.

Treaty and War Powers.—Congress, no doubt, may exercise legislative power in carrying out the provisions of treaties. Such powers, in the past, however, have not been largely exercised and their limits are not definitely set. It should also be remembered that in the District of Columbia, territories and reservations the Federal Government has complete powers, and that in time of war its power to raise and support armies and to provide a navy carries with it the power to do whatever is necessary to protect the health of soldiers and sailors, even within state lines.

The United States Public Health Service.—The most important branch of the Federal Government in its relation to health is the Public Health Service. The following concise statement regarding its development and organization was supplied by Dr. Charles Bolduan:

The Public Health Service dates back to the end of the Eighteenth Century when, in 1796, steps were taken for providing medical and

surgical relief to merchant seamen. At first this was financed by a per capita tax collected from the seamen, the funds being handled by the collectors of customs in the various ports. Subsequently this was changed into a tonnage tax, collected through the same channels. This explains why the marine hospital work (the precedent of the present U. S. Public Health Service) came to be lodged in the Treasury Department, for the collection of customs was naturally a branch of the Treasury Department's work. With the enormous growth of the American Merchant Marine in the first half of the Nineteenth Century this method of providing for the merchant marine was found to be inadequate and the government, therefore, established "marine hospitals" at various important points.

In an effort to guard against the introduction of dangerous pestilential diseases from without it was natural that the officers of the marine hospitals, stationed as they were at the important ports of entry, should come into close relation and take an active interest in maritime quarantine matters. In addition to this, the repeated introduction of yellow fever into the southern states and the alarm occasioned thereby caused repeated calls to be addressed to the Federal Government to take charge of control measures at the infected points in order to prevent the spread of disease to other points in the United States. There being no special Federal health agency, these calls were naturally referred to the United States Marine Hospital Service. More and more, therefore, this Service began to undertake federal public health activities, a fact which was recognized by Congress when, in 1902, it changed the name of the service to the United States Public Health Service and Marine Hospital Service. More recently still, in 1912, the name was still further changed to its present designation, namely the United States Public Health Service.

The United States Public Health Service is a bureau in the Treasury Department. At its head is the Surgeon-General. He is assisted by a staff of Assistant Surgeon-Generals. Most of these have charge of important functional divisions. As at present organized, the work is carried on under the following divisions:

Division of Personnel and Accounts. (As its name implies, it has to do largely with matters of internal administration.)

Division of Marine Hospitals. (In addition to caring for merchant seaman, this division has charge of all the medical and surgical relief work for discharged soldiers, sailors, marines and nurses who are beneficiaries under the War Risk Insurance Act.)

Division of Maritime Quarantine. (This conducts almost all the maritime quarantine stations for the United States and the insular possessions.)

Division of Domestic Quarantine. (This controls the important field relating to the control of diseases through the interstate traffic.)

Division of Scientific Research. (This is a large division engaged in studying the diseases of man through field investigations and laboratory work.)

Divisions of Sanitary Reports and Statistics. (This division collects information regarding the prevalence of communicable diseases, disseminates it through publications and otherwise to Health Officers and Sanitarians throughout the country.)

Division of Venereal Diseases. (This recently created division was established by Congress primarily to safeguard the nation's manhood against the ravages of venereal infection.)

Section of Public Health Education. (A recently established activity for promoting public health through popular health education.)

The personnel below the rank of the Assistant Surgeon-General consists of Senior Surgeons with a rating corresponding to that of Lieutenant-Colonel in the army, Passed Assistant Surgeons with the rating of Captains, Assistant Surgeons with the rating of 1st Lieutenants, Scientific Assistants with the rating of 2nd Lieutenants, Pharmacists, Orderlies, Technicians, and other attendants with the rating of noncommissioned officers. These grades are largely for the convenience of these Federal officials in order to determine relative rank when sitting upon boards or commissions with army and navy officers. The Public Health Service is a civilian and not a military branch of government, although during the world war it was declared a branch of the military service by the President of the United States, being continued under its usual organization.

The functions of the Public Health Service have been described, in reports upon its activities, as being of four kinds. *Police duties* are first mentioned. These include the maintenance of quarantine and the prevention of the spread of disease from one state to another. The second activity is that of *investigation.* With increased appropriation from Congress the Hygienic Laboratory of the Public Health Service at Washington should be made a big center of research in preventive medicine, for it is obviously fitting that the Na-

tional Government should undertake the solution of the nation's great disease problems. The third activity is that of *demonstration.* With the cooperation of the state and local agencies, special pieces of work may be undertaken to prove the value of rural sanitation and other health measures. The fourth activity is that of the *coordination* of state and local activities in various parts of the country in order "to secure a synchronous attack upon any disease with uniformity of method over the entire area of the United States." For example in the national campaign against venereal diseases Congress appropriated one million dollars under the Chamberlain-Kahn bill and under the cooperating agency of the Public Health Service the various states waged a uniform and successful campaign.

The Public Health Service is the principal and most important health agency of the Government. It has been accredited with all the powers that Congress can give it for doing health work. The nature of its activities is limited by the Constitution and the extent of its activities is limited by the failure of Congress to give it sufficient appropriations.

Other Federal Health Agencies.—There are other departments in the Federal Government which are doing rather special health work. The Children's Bureau in the Department of Labor was established in 1912. It is empowered by Congress to promote the protection of maternity and infancy and to cooperate with state and municipal agencies in protecting the welfare of the growing child. The Bureau of Education in the Department of Interior concerns itself with the physical as well as the mental development of school children. The Home Economics Division of the Department of Agriculture is promoting better nutrition of children by means of educational literature and by practical demonstrations of food values. Many of the departments of the government are doing lesser amounts of health work and much is apparently being lost through lack of centralization and coordination. Attempts have already been made

to secure a central health administration and this movement has doubtless been strengthened by the recent organization of a Ministry of Health in both England and Canada.

STATE HEALTH FUNCTIONS

Under our form of government each state bears the responsibility for its health conditions and upon the state legislature, as the supreme power of the state, this responsibility primarily rests. The Federal Government has no right to interfere in those matters which affect only the state itself, but the towns and municipalities within the state are all bound to enforce the state law. The legislators, limited only by the constitution and responsible only to the electorate, are supreme in their power to determine what health regulations shall be made and what official organization shall be provided by each municipality and by the state at large to administer public health. Since public health administration within the state is directly dependent upon the law it may be profitable to consider the principles of health legislation at this point.

Public Health Laws.—Public health laws may be divided into two groups; those statutory laws creating the public health *organization,* and those, statutory and otherwise, which govern public health *administration.*

The first law providing for health organization was the Massachusetts law of 1797 establishing Boards of Health for towns and giving each board power to "make such regulations as it judges necessary for the public health and safety." Since then the other states have made similar laws, the last enactment being that of Nevada in 1905, while many of the large cities have had special sanitary provisions incorporated in their charters. The type of local organization has varied in different states depending upon whether the administrative unit of government was the township or the county. The local authorities are required to keep the state authorities in-

formed as to the sanitary conditions of their districts and in all cases local health ordinances must not contravene the laws of the state. Since 1855 each state has enacted a law creating a State Board of Health or its equivalent.

In the legal side of public health administration, common and constitutional as well as statutory laws are involved. The *common law,* or lex non scripta, consists of the court decisions made in the course of administering justice. The decision of a lower court or the opinion of an attorney has little value as a precedent, but the decision of the supreme court is binding upon subordinate courts until overruled. *Statutory laws* are enacted by legislatures upon the basis of common law and their official interpretation has the force of additional legislation.

Coincident with the growth of common law there is usually the establishment of *institutions* such as quarantine. These institutions, however, may become antiquated and abandoned as the quarantine of yellow fever. When conflicting with either statutory or constitutional law they are not lawful.

All authority for the protective operations of government including the preservation of public health is derived from what is known as *police power,* an inherent function of government. In its exercise we find cases where there is sanction for otherwise illegal acts, such, for example, as the violation of personal or property rights to protect the safety of the people in great epidemics. It is a fundamental social principle that *personal liberty ends when individual action menaces public safety.* Upon this principle are based many public health procedures, such as the prevention of nuisances and the control of communicable diseases.

The use of *license* is essentially police in nature. A license may be issued with a slight fee as in licensing milk dealers where it is the license rather than the fee which serves to restrict or regulate the business. On the other hand, the issuance of licenses at a prohibitive cost has been a reasonable use of police power in restraining the liquor traffic. A tempo-

rary license, or one which covers a single act, is ordinarily called a *permit.*

Where a health officer is given *power of discretion* he may do any act within that discretion, and all that he does will be held to have been done with the express authorization of law. Should the health officer abuse his power of discretion he is amenable to prosecution, but the act to be criminal must be wilful and corrupt, and proof of this rests upon the complainant. If the officer has deviated from his legal authority through a mistake in interpreting his power or a mistake of fact in applying the law he is liable as a private wrongdoer and responsible in such damages as may be proved.

An officer is not subject to a private action for neglect of an exclusively public duty even to a person specially injured thereby, and in some cases even though the act were unlawful and malicious. If discretion be left entirely to the administrative officer, there is no way in which he can be forced to act. In the enforcement of statutory law, an officer is subject to mandamus and also to probate action whenever he shall deviate from his prescribed limits of duty.

Some laws like quarantine are mandatory as to action, but discretionary as to method. In court proceedings if the law be specific the only questions which may arise are those of fact; if discretionary, questions of fact, reasonableness and extent of discretion may be presented.

A city's administration depends upon fixed rules. They are either written *regulations* or unwritten *usages.* When a penalty is attached to a violation of the rules or regulations of the board of health, such rules must be published and due notice given before they can be made effective. Violations of the regulations may be punished by indictment, action being uniformly brought in the name of the town or city.

Injunction is applicable to prevent executive action, the taking or impairment of property or the creation of nuisances. It is not used to direct or restrain the exercise of discretionary authority.

A public health *nuisance* is a state of affairs which is dangerous to public health. Obviously a thing may be a nuisance under either common or statutory law. In a case of exigency the health authorities may summarily abate the nuisance, but if the owner of the property cannot get a formal trial before the abatement he is entitled to a hearing afterward. The burden is then upon the authorities to justify their action.

State Health Administration.—Turning now to a consideration of state health administration we find that the oldest type of organization placed the administration of public health in the hands of a Secretary of the State Board of Health. He was the executive officer and his activities were guided by the policy and wishes of the Board. Recently many states have changed their type of organization from a State Board of Health to a State Department of Health under the direction of a Commissioner with an Advisory Council. New York initiated this movement with its law of 1912. Massachusetts soon followed suit with a similar law, containing a few modifications and since then Maine, New Jersey, Connecticut, California, Ohio and several other states have adopted some form of the New York-Massachusetts plan.

The work to be done is practically the same no matter what the type of organization although naturally the extensiveness of the work done by each state varies with the size of its health appropriation, the efficiency and number of its personnel and the extent to which the state supervises local health administration. We shall use the new type of organization in describing state health activities, because it is already becoming the common type of organization and because it lends itself well to a description of health functions.

The essential features of the New York State Department of Health are set forth in the law which created it. There are provisions for a Commissioner, a Public Health Council, a Sanitary Code, the employment of District Health Officers, and the creation of various Divisions.

The *Commissioner* is appointed for a term of six years and must have had ten years experience in the practice of his profession and in public health duties. The Deputy Commissioner is appointed and at pleasure removed by him. The duties of the Commissioner include a general supervision of the health activities of the State, the enforcement of public health laws and the sanitary code, the study of health conditions, and the keeping of vital statistics, while his powers include the right to modify a local ordinance and the right of entry which he may delegate to any of his employees.

The *Public Health Council* is composed of the Commissioner and six other members, three of whom are physicians, appointed by the Governor for a term of six years and receiving a salary of $1000.00 per year over and above necessary travelling expenses. The Council has no executive or administrative duties but acts in an advisory capacity to the Commissioner and may at any time offer suggestions.

The *Sanitary Code,* consisting of rules and regulations affecting the security of life or health, is enacted by the Public Health Council. The provisions of this Sanitary Code have the force and effect of law in all parts of the State and are only restricted in that they shall not discriminate against any licensed physician. These regulations are filed with the Secretary of State. In enforcement they supersede any local ordinances which may be inconsistent with them, and include besides sanitary regulations a statement of qualifications for Directors of Divisions, Sanitary Supervisors, Local Health Officers, and Public Health Nurses.

It is to be noted that the legislature has delegated a limited amount of "law-making power" to the Public Health Council. In such a case the delegation of power is judicious and progressive, for only a body of experts is qualified to work out the details of public health regulations.

It is definitely provided that there shall be in the Department of Health nine *Divisions,* namely:

1. Division of Administration.
2. Division of Sanitary Engineering.
3. Division of Laboratories and Research.
4. Division of Communicable Diseases.
5. Division of Vital Statistics.
6. Division of Publicity and Education.
7. Division of Child Hygiene.
8. Division of Public Health Nursing.
9. Division of Tuberculosis.

A division of Venereal Diseases has since been added.

Sanitary Districts are formed by the Health Commissioner, and District Health Officers are appointed by him. It is their duty to keep in touch with local health officers, aiding them when necessary, to make special surveys, hold conferences, adjust local questions of dispute, study mortality, promote the registration of births, inspect camps and Indian reservations, enlist physicians for emergency service, and assist in public education, and the enforcement of the sanitary code.

Administrative Functions.—Let us consider briefly the activities of the various divisions of the State Department of Health.

One of the first recognized duties of the state has been the collection of *vital statistics*. This includes the recording and analyzing of data concerning deaths, births, marriages, population, and diseases. The keeping of vital statistics is the bookkeeping of a state by which it keeps a record of changes in the population, which represents its great item of wealth. Just as an industrial concern keeps an account of its material assets and liabilities so the state must keep a record of its human assets and liabilities. It must know whether it is gaining or losing and where and how. If disease is to be prevented and lives are to be saved careful records must be kept to show where, when and how diseases and deaths are occurring.

The recording and interpretation of vital statistics is a science in itself and highly trained *vital statisticians* are employed for this work. The layman may not be particularly interested in the methods of interpreting statistics but he will at least wish to know what is meant by the most commonly computed rates.

The *birth rate* is the number of births annually per thousand population. The crude *death rate* is the number of deaths annually per thousand population. We also have what are termed *specific death rates* which state the number of deaths per thousand or per 100,000 population for specific diseases. For example a low typhoid death rate is 4.3 per 100,000.

Another important figure is the *morbidity rate* which is the number of cases of specific disease per thousand population (sometimes expressed as the number per 100,000 population). The *fatality rate* is the number of deaths from a specific disease per 100 cases (the per cent fatality). We say, for example, that among pneumonia cases the fatality rate was 33.

By such figures our "life and death bookkeeping" shows us how we can tell just where our various communities stand in the matter of life-saving and health. When we realize that such figures show whether we live in a safe and healthy community or a dangerous and sickly one, the statistics of our state and local health officers become most interesting reading. The registration of births, marriages and deaths is also important for legal, social and property rights.

The Division of Administration, which is presided over by the Health Commissioner, includes a supervision over the work of the district health officers, accounts, salaries, expenditures and other administrative details.

An increasingly important division is that of *Publicity and Education.* It embraces the publicity work of the State Department of Health, such as the circulation of the reports issued by the department, publicity work through the news-

papers, the showing of health exhibits in various parts of the state, the issuing of pamphlets and instructive material to school children and to people generally, lectures, moving pictures and all of the numerous and valuable activities by which the state health department places before the people the important principles concerning the care of the health.

The functions of the *Division of Sanitary Engineering* are to safeguard the water supplies and to insure proper waste disposal throughout the state. Such a department maintains facilities for water and sewage analysis and is able to furnish the advice of an expert Sanitary Engineer in any problem of water supply and waste disposal. These problems have been considered in a special chapter.

The special duties of the *Division of Communicable Diseases* include activities in controlling and limiting the spread of various communicable diseases. An epidemiologist is usually attached to the Department, who promptly investigates incipient epidemics enabling the division to take more prompt and intelligent steps in restricting the disease.

The *Division of Child Hygiene* maintains a personnel of trained workers in subjects of infant and child welfare, who make surveys, develop special state and local campaigns to improve the hygienic conditions of maternity, infancy and childhood and cooperate with private child-health agencies through the state.

The *Division of Public Health Nursing* determines the qualifications of the public health nurse, employs a corps of nurses to assist district health officers and broadens the usefulness of such nurses as are employed by various communities in the state through its assistance and cooperation.

The *Division of Laboratories and Research* provides free laboratory diagnosis of communicable diseases, prepares and distributes vaccines and antitoxins to the medical profession and carries on public health research.

The *Division of Tuberculosis* directs the operation of State Tuberculosis Hospitals and Sanatoria, and assists local

communities to combat the disease by investigating conditions and showing the value of early reporting, dispensary service, milk control and other measures.

Nearly all of the states at one time established a *Division of Venereal Diseases* as a result of the campaign waged by the Federal Government. In several states this special division has now been discontinued and the work placed under the Division of Communicable Diseases.

The organization of a state health department is more or less elastic and not all of these divisions are present in every state. New divisions may be established and old divisions may be abolished to fit the need of the occasion.

LOCAL HEALTH ADMINISTRATION

Authority.—Before discussing local health administration it may be well to say something about the division of authority between the state and local governments since their relationships are widely varying. In Pennsylvania for example there is a centralized system. The local organization is under the control of the state organization. In Massachusetts the Legislature has given to the state organization only the power to *advise and investigate* with no direct control over the local health authorities. In every state the supreme authority is the state legislature and it can do as it sees fit in giving power to the state organization.

There are dangers in either of the extremes mentioned. If the State Department of Health has power over every local health officer it must accept the responsibility for his activities and the townspeople have an opportunity to blame the state department if anything goes wrong. On the other hand, if the State has no power over local health officials, dangerous conditions may remain uncorrected because of inefficient and careless local administration. We are perhaps tending toward the more centralized system in the country as a whole but it would seem that the system which allows the state de-

partment limited but not complete control over local authorities or additional power in emergencies is preferable to either extreme. In some states, legislation is being enacted giving the state department power to administer health in any community when the welfare of other communities in the state may be endangered or injuriously affected. For example, if the quarantine measures of a town are insufficient the state may step in and make its regulations more strict. This sort of law leaves the responsibility for community health with the local or municipal officials but gives the state power to protect the health of the whole state whenever it may be endangered by local inefficiency.

Local Health Organization.—In any case the major duty of enforcing public health law and maintaining healthful conditions is with the town or the city. Throughout the country there is a fairly uniform local health organization which consists of a Board of Health with a Health Officer or an Executive Secretary. Upon the Health Officer there rests the responsibility of administering health and upon the Board of Health there rests the responsibility of directing health activities. The above discussion of public health laws describes the health officer's responsibility and his powers of discretion regarding them.

There is a tendency in some places to place responsibility upon the local health officer instead of leaving it with the board of health. In some states the health officer may be appointed to replace the board of health and in Massachusetts there has recently been legislation allowing Local Health Departments to be formed—a type of organization similar to that of the state. Here a local Health Commissioner is appointed with an advisory committee. This sets the responsibility upon the health officer but gives him the benefit of advice and support from a committee or council.

The activities of a local health department are many and varied. It is its duty to enforce all of the state laws regarding health and disease, and to enforce in addition such ordi-

nances or local regulations as may be in effect and related to public health.

An important duty of the local department is the maintenance of a *public health laboratory* where laboratory diagnoses for infectious diseases may be made and where examinations of the water, milk, butter, vinegar and foods are carried out. Laboratories in small communities usually begin with the examination of water and milk, and then add diagnoses for diphtheria, tuberculosis, septic sore throat, syphilis and other infectious diseases. In addition such a laboratory often makes tests for the purchasing department of the city, analyzing flour, coal and other substances.

Other activities include the isolation and quarantine of infectious diseases, subsequent disinfection where necessary, the abatement of nuisances, the supervision of hotels and restaurants, a supervision over sewage and garbage disposal, the supervision over housing conditions, and the administration of special activities such as public health nursing, infant welfare, city hospitals, the control of epidemics, the collection of vital statistics, the making of regular reports to state department of health, and many other matters. The problems of water and food supplies, milk control, and waste disposal will be considered in special chapters as will the subject of school hygiene.

County Health Unit.—The old custom in rural communities of employing practicing physicians to supervise health conditions on a part-time basis is giving way to the more economical and effective installation of a county health unit. This is located at the county seat or other convenient point. The project is of varying size and scope according to the extent of county resources. Funds are sometimes augmented during the first two years by grants from the state and the International Health Board of the Rockefeller Foundation, or by aid from the U. S. Public Health Service.

A minimum health unit consists of a public health officer, a sanitarian and laboratory man combined, and a public

health nurse. This small unit convinces the county of the value of local health work and gradually secures an adequate staff. So satisfactory have been the results of these projects that over four hundred full-time county health units are now functioning in the United States.

The Health Officer.—From such a list of activities it is obvious that public health administration involves a variety of tasks. The local health officer must know the fundamentals of sanitary engineering or sanitation and the important facts of hygiene. By training the sanitary engineer or the physician is best adapted for this type of work, but either should have a supplementary training. Public health administration is a distinct calling demanding a knowledge of a different group of subjects than go to make up any other profession. In this country we are rapidly learning that the public health officer must be a specially trained man and the number of men with special training in public health is rapidly increasing.

Unofficial Health Activities.—There are many national health organizations in the United States and many local health societies interested in specific or general health problems. It seems reasonable that the function of these private health organizations—and it is a useful function—is to develop those phases of health activities which the health department of a community is not yet ready to handle or which it cannot well handle because of the particular problem involved. For example, cancer research cannot be carried out by the individual community, it might be done by the U. S. Public Health Service but excellent work may be done by a society specifically interested in the problem. Activities like the prevention of tuberculosis, which would reasonably fall under the work of the organized health authorities, should be cared for by private organizations to that extent to which the local community is not able to handle the problem.

The society of professional public health workers is the American Public Health Association. It includes not only

the majority of people professionally engaged in public health but an increasingly large number of people with special public health interests. Its official organ is the *American Journal of Public Health.*

Other societies and health organizations of national importance include: *The American Red Cross,* Department of Health Service; *The American Association of Industrial Physicians and Surgeons; The American Social Hygiene Association; The American Society for the Control of Cancer; The American Child Health Association; The International Health Commission; The Life Extension Institute; The National Child Welfare Association; The National Committee for the Prevention of Blindness; The National Committee for Mental Hygiene; The National Committee on Malaria; The National Organization for Public Health Nursing; and The National Tuberculosis Association.*

CHAPTER XVI

SCHOOL HYGIENE

The Problem.—The duties of organized government in School Hygiene are extensive and important. The state by its excellent compulsory school attendance law places almost a third of our total population in this "factory" for the development of the mind. Dr. Osler has said that most of the diseases which cause death in middle life are developed from conditions begun in childhood. America has been somewhat slow in developing the subject of School Hygiene but the examination of ten million of our population in the selective draft brought home forcibly to the American people the fact that one-third to one-half of our young men were unfit for full military service because of physical defects many of which were correctable. We have begun to face the problem of properly caring for our school children in a serious and right-minded fashion realizing the vast amount of work which lies before us.

The most important development in school health during the last decade has been the development of positive health training for school children in order that they might have proper habits, attitudes and knowledge in matters of health. Public Health is concerned with increasing the happiness rate as well as decreasing the death rate. A program which will maintain the buoyant health of school children is naturally to be preferred to one which merely takes care of the physical debilities which have already developed. In this constructive program of health education this country has taken a reasonable degree of leadership and the activities for promoting the positive health for school children have become a fundamental part of our school health program.

The school system is a public institution and the student of Community Hygiene will desire a fundamental knowledge of the important activities which constitute a well balanced school health program. The subject is broad and complex. The discussions here must be general without the attempt to present technical facts which are necessary for the members of school or health departments who are responsible for the conduct of this work. We shall not attempt to define the relative responsibilities of the educational and health agencies of the government in this field. Obviously there is both an educational and a health aspect to the problem. The personnel of both departments is necessary and a division of the details of administration must, for the present at least, frequently depend upon local conditions. The question of who does the work is not so important as that the work is done and done properly.

The School Health Program.—The Committee on School Health Program of the American Public Health Association in its first report (*Amer. Jour. of Public Health,* March, 1922) divided school health activities according to the following classification:

I. *Health protection.*
   a. Sanitation of the school plant.
   b. Examination.
      1. Physical.
      2. Psychological.
   c. Communicable disease control.

II. *Correction of defects.*
   a. Follow-up work by the School Nurse who visits the home to see that steps are taken for correction of the defects.
   b. Special classes. (Open air Classes, Sight Conservation Classes, etc.)
   c. Public Clinics for correction of physical defects of children whose parents cannot meet the expense.

III. *Health promotion.*
   a. Hygienic arrangement of the daily study program.
   b. Physical activities. (Physical training program.)
   c. Health instruction and motivation. (Including training in health habits.)

A review of the history of the public schools of America will show that the sequence in this classification is roughly according to the chronological development of health work. Compulsory education places a definite responsibility upon society to make sure that children are not sent to school in a place so unsanitary as to cause disease. School sanitation, therefore, was one of the first items to receive consideration. Then we became aware that communicable diseases among children were spread because of the intimate contact at the public school and it became necessary to combat these diseases systematically. We realized also that without a knowledge of the child's physical and mental condition unreasonable burdens might be placed upon him and accordingly there has developed the practice of physical and, more recently, psychological examinations for school children. The physical examination of school children demonstrated the existence of innumerable physical defects and methods of securing their correction through the follow-up work of the public health nurse, the development of special health classes and clinics were provided. Then came the realization that it is as much a responsibility of the public school to promote the health of the well child as to provide for the improvement of the sick child. There developed, therefore, more consideration for the hygienic arrangement of the school program, organized physical training activities, and most recently the health education movement for systematic instruction and motivation in proper habits of living.

Instead of using the above classification of school health activities for consideration in this chapter, we may divide them according to the nature of the task into three easily remembered divisions:

1. The control of school sanitation and the provision of a proper physical environment for the school child.

2. The prevention and eradication of disease.
3. The promotion of health among well children.

We shall consider each of these problems in order.

1. SANITATION OF THE SCHOOL PLANT

In spite of the early attention which was given to school sanitation, a large percentage of our present school population is housed in buildings which have low standards of construction and sanitation. It is unsound and unfair for us to require children to attend school under living conditions lower than those which we demand in our standards of living elsewhere. The sanitarian and school architect need the support of an enlightened public opinion in their task of providing and maintaining a proper school plant.

There are innumerable details. Safe water must be provided and distributed through individual cups or by drinking fountains which are so guarded that they cannot be mouthed by the children when they drink. Enough light must be supplied from the pupil's left or from very high at the right and never from the front or rear. The blackboard must receive sufficient light and present a dull surface. No seats should be so far from the light as to make it difficult for the pupil to read. The entrance and cloak room should be sufficiently large and properly ventilated with space for hanging clothes and a place for wiping the feet. The entrance should not be directly on the street and there should be one entrance for 300 pupils. Windows should be regular with small spaces between them and should have small white frames which open easily at the top. Dust should be avoided, in so far as possible, by wiping boards with a damp cloth and by preventing the stirring up of the dust immediately before school or at recess since it takes from fifteen minutes to one hour for dust to settle. The ventilation system should supply a constant change of air at the proper temperature.

The length and width of schoolrooms should be in the approximate ratio of 3 to 2. In room construction, corners should be avoided for ease in cleaning. The walls should be a light green with the upper three feet whitened and the lower five feet may well be of tiling or some such durable material. Ceilings should be kept white and the floor of hard wood kept smooth. Holes in the floor may be filled with a mixture of curd and slaked lime in proportion of five to one. This produces a hard waterproof cement.

The pupil's desk should be selected with care. It should not have sharp corners, it should be easy to clean, it should not interfere with the teacher's view of the pupil, it should be noiseless and so shaped that the sitting posture is not likely to harm the spine, thorax or the eye. There should be measuring and reseating of pupils in seats of proper size at least two times a year. This is easier if one third of the seats in the room are adjustable since classes vary in the size of pupils. The top of the desk should be on a plane with the elbow. If it is lower than this the spine is injured. The back rest should at least support the lower third of the spine.

The toilets should be in a convenient place so that retention which may lead to maiming or weakening the bladder or producing sex irregularities may be avoided. The toilet should be well ventilated and the seat should be sufficiently low and U-shaped. Epidemic vulvovaginitis has been reported in schools as having spread from toilet seats so high that it was necessary for small girls to drag themselves over the front.

2. THE PREVENTION AND ERADICATION OF DISEASE

In this group of activities we would include:

1. Prevention of communicable disease.
2. The physical examination of children.
3. The correction of physical defects and the checking of incipient maladies.
4. The dental care of school children.

Personnel.—Four types of specially trained people are necessary for the administration of the medical side of school inspection, the physician, the school nurse, the dentist and the dental hygienist.

The *physician* must be a capable diagnostician with a fondness for the type of work and with a public health point of view.

The *school nurse* has a variety of duties in assisting the doctor in the routine of medical inspection, visiting homes and interviewing parents, visiting schools and examining children for infectious diseases, assisting in treatment at the school clinic and occasionally giving instruction in hygiene to the pupils. It is therefore, highly important that she have the ability of making the proper contact with pupils and parents, as well as the ability to detect communicable disease and assist the physician. If she is to instruct in the school she should know something about teaching as well as nursing because they are two distinct professions. It no more follows that a nurse can teach than that a teacher can nurse. The nurse is the point of contact between the family, the child and the school medical authorities and upon her common sense and practical work often depends the success of the plan. Her failure to secure the cooperation of the parents in having the bodily defects of the child corrected and in maintaining better home conditions means a failure to secure a practical result of health improvement. The woman who can appreciate the problems of the homes she visits adds something to the value of her work which detailed scientific knowledge cannot supply.

The work of the *dentist* may be orthodontia, repair work or prophylaxis but it is work at the chair and not widely different from routine practice.

The *dental hygienist* stands to the dentist in much the same relation as does the nurse to the physician. She must work with the children and perhaps in some instances with the

parents. She examines the teeth and fills out a record card, prepares the patient for the dentist and cleans the teeth.

Communicable Disease Control.—The responsibility for preventing the spread of communicable disease rests with the health department. As public health procedures became better organized, it was apparent that the opening of the public schools frequently furnished the occasion for the rapid spread of one of the communicable diseases of childhood. In order that the school might not become a means of spreading communicable disease, the cities of this country during the last decade of the nineteenth century, began the organization of a school medical and nursing force. Sometimes this work is carried on by the health department, and sometimes by the school department, but in any case, the health officer must receive the promptest possible information when communicable disease appears. Both school physicians and school nurses have other tasks, but the control of communicable disease is one of their important duties.

With the opening of a new term of school a prompt inspection is made of all children, and those who show symptoms which suggest the presence of communicable disease are immediately excluded from school, and the health department is notified in order that suitable steps may be taken for securing a prompt diagnosis and quarantine, if that is necessary. In many cities, there is a daily inspection for signs of contagion which is carried on by the school nurse. Teachers are trained to note any sign of ailment in the pupil, and children who show any signs of illness are sent immediately to the school nurse or school physician. A prompt exclusion of these cases, and an organized system for inspecting each child who comes back to school after an illness to see that he is no longer infective,—when accompanied by prompt and efficient action on the part of the health department to see that disease is not spread in the home,—has proved a most important weapon in limit-

ing the spread of children's diseases. During a time of epidemic, the inspection of all school children each morning is most systematically carried out. The practice of closing city schools because of children's diseases has been done away with, because it was found that by systematic inspection in the public schools the spread of the disease could be better controlled than if the school were closed and children were allowed to play in the streets and upon playgrounds where equal opportunity for contact would occur without any opportunity for isolating incipient cases. In rural schools where children are naturally isolated by living some distance apart, it may be regarded as feasible to close schools during an epidemic of contagious disease.

Physical Examination.—Dr. Crowley, Director of School Health for England and Wales, gives the following figures indicating the proportion of elementary school children having diseases and common defects requiring treatment:

Defects of vision 10%; defects of hearing 5%; ear diseases 3%; marked decay of the teeth 50%; (some decay 80-90%); Tuberculosis 2%; heart disease 1%; malnutrition 10%; ringworm 1%.

The report from the Joint Committee on Health Problems in Education, entitled "Health Education," gives the following estimate of the number of school children suffering from physical defects: 0.7 per cent suffer from organic heart trouble, from 50 per cent to 98 per cent from decayed teeth, 1 per cent to 5 per cent from tuberculosis, 30 per cent to 40 per cent from adenoids and diseased tonsils, 25 per cent from defective vision, 25 per cent to 40 per cent from defective posture and foot arches, 15 per cent to 25 per cent from malnutrition.

The physical examination of the child, however, is even broader than this list of defects and should include a study of cleanliness, nutrition, height and weight, heredity and environment, and an examination for squint, external eye disease, defective hearing, adenoids, ear discharges, enlarged

glands, defective teeth, acute rheumatism, chorea, heart disease, lung disease, bronchitis, venereal disease, rickets, anemia, headache, diseases of the skin, and deformities. The card on page 314 is one devised by the U. S. Public Health Service for recording the results of physical examination.

This form is more elaborate than many communities are in a position to use. In any case the record card should always be of suitable size for filing and should be made a permanent record so that the health progress of the child may be ascertained at any time.

Most states now require by law some kind of health or medical inspection of school children. In some places, this inspection is limited to tests for vision and hearing which are made by the teachers, in other places the inspection is made by the nurse, and includes in addition an examination of the teeth, the throat, the glands of the neck. In a few places the teacher makes a rather comprehensive health inspection. In neither case is the inspection as complete as a physician's examination which includes an examination of the heart and lungs together with a study of the general physical condition. There is no uniform method in the examination of school children and often so many children have been assigned to each examiner that the work has been hasty and inaccurate.

Whatever the system involved, the object of the physical examination or health inspection of children is not to diagnose whatever conditions may be found and prescribe for the treatment, but rather to determine whether there exists a defect or condition which neeeds attention. As yet the public school has not assumed the function of correcting the defects of children but only the responsibility of notifying parents of conditions which need medical or dental attention and securing further assistance for those families which are not able to have the necessary correction made without aid from the community.

(Child's surname.) (Given name.)	(Name of school.)	(City, town, or district.)	(County.)	(State.)

Sex: M. ....., F. ..... Color: W. ..... C. ..... Age .....Date of birth: Month ....., day ....., year 19....

CHILD'S SICKNESS RECORD DURING SESSION

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total.
Number of days enrolled											
Number of days present											
Number of days absent—Toothache											
Number of days absent—Colds											
Number of days absent—Other sickness											
Number of days absent—Other causes											

CHILD'S SCHOLARSHIP RECORD: Age at which child commenced school..... What grades were repeated by child prior to this session?..... Grade in which child is enrolled this session ..... Character of child's work at school during the present session (mark the proper grading with X): Excellent ..... Good ..... Fair ..... Poor ..... Very poor ..... Was child promoted or failed at the end of this session? ..... If child failed this session, what in your opinion were the causes of failure?.....

314

(Above to be filled in by teacher.) (Below to be filled in by nurse.)

Name of parent or guardian ..... Occupation ..... Remarried: Father ..... Mother .....
Father living? ..... If dead, state year ..... Cause of death .....
Mother living? ..... If dead, state year ..... Cause of death .....
Number of brothers living ..... Dead ..... Cause of death .....
Number of sisters living ..... Dead ..... Cause of death .....
If child has any of the following diseases during the present session, enter month in which it occurred: Chicken pox ..... Diphtheria ..... Measles ..... Mumps ..... Scarlet Fever ..... Smallpox ..... Whooping cough ..... Other diseases causing absence from school (state what and give month of occurrence).....

Any tuberculosis in child's home ..... Has child been exposed to tuberculosis in home .....
Vaccination (smallpox) ..... No. times ..... When last successful (year) ..... Vaccination (typhoid) ..... State year .....

U. S. PUBLIC HEALTH SERVICE, PHYSICAL EXAMINATION OF SCHOOL CHILDREN—Child Hygiene Form No. 4.—Revised Feb., 1920. 2—9644

(OVER.)

EXAMINATION AT BEGINNING OF SESSION

Date of Examination ....., 193

Height (with or without shoes) ..... ins.
Sitting Height ..... ins.
Weight (with or without shoes)—no wraps ..... lbs.
Chest expansion: Exp. ..... Ins. .....
Hearing (watch): Right ..... Left .....
Vision (Snellen): RV ..... LV .....
Vision with glasses (Snellen): RV ..... LV .....
Teeth, number defective .....
Teeth, number missing .....
Teeth, number fillings .....
Use of toothbrush .....
Enlarged tonsils .....
Mouth breathing .....
Skin eruptions .....
Pediculosis .....
Other defects or deformities .....

Height and Weight Measurements at End of Session.

Date of making ....., 193

Height (with or without shoes) ..... ins.
Weight (with or without shoes)—no wraps ..... lbs.

(ABOVE TO BE FILLED IN BY NURSE)

Date of Examination ....., 193

Defects of auditory apparatus .....
Defects of visual apparatus .....
Trachoma .....
Nasal defects .....
Throat affections .....
Heart disease .....
Pulmonary disease .....
Mental and nervous disease .....
Orthopedic defects and diseases .....
Speech defects .....
Spinal defects .....
Blood parasites—malarial* .....
Intestinal parasites* .....
Skin and scalp conditions .....
Nutrition: Exc. .... Good .... Fair .... Poor .... Very poor....
Mental age .....
Other defects or deformities .....

*Microscopic examination to be made only in suspected cases, but routine in infected localities.

(ABOVE TO BE FILLED IN BY MEDICAL INSPECTOR)

(BELOW TO BE FILLED IN BY MEDICAL INSPECTOR.)

TREATMENT RECORD

Date .....

Nature of defect .....
Treatment advised .....
Date of notification of parents .....
Case treated by ..... Date .....
Nature of treatment .....
.....
Result of treatment ..... Date .....

2—9644 ....., *Medical Inspector.*

The data from different cities and towns have not been comparable in the past because there was no agreement as to what should constitute a remediable defect. It has been found that without some such agreement different physicians examining children in the same city obtain widely different results as to the number of defects found. The American Public Health Association and various other agencies are interested in developing a standard method for recording the physical conditions of school children so that it is hoped to have comparable data in the future, if cities are willing to adopt such an approved plan.

It is more to the point here to indicate the present tendency and the best practice in health examination rather than to discuss the wide variations in the present practice. Many communities are now organizing a pre-school or "get ready for school" health campaign in which careful examinations are given to pre-school age children by well qualified physicians. Following these examinations, it is possible to have many physical defects corrected before the children enter school. Instead of hurried, annual inspections, the tendency at present is to provide a thorough examination for the child when he enters school. This is to be made by a physician. The child's clothing is removed. The examination is complete. One or both of the parents are present. Such a careful examination is repeated in the fifth grade and at the end of the elementary school period. Health inspections by teachers or nurses take place between these periods. The next step which is likely to come in the systematizing of record keeping will be the preparation of a standard life card upon which the pre-school examination of the child may be recorded, and this card will follow the child throughout his public school experience.

Mental Examinations.—In many cities a mental examination is provided for at least a part of the school population. This is an examination made by a psychiatrist or expert in

mental abnormalities. It is used to determine whether the child has defective mentality rather than to determine the intelligence of the child. Intelligence tests are now made upon large groups of school children and are quite different from the psychiatric examination.

The importance of this examination will be seen from figures collected by the National Committee on Mental Hygiene. In the study of the school children of a large city, 13.2 per cent were found to be mentally abnormal and unstable. Of the cases of juvenile delinquency 75.9 per cent were found to be mentally abnormal. An examination of adults who were dependent upon the community for support showed that 72.9 per cent were abnormal.

The Examining Room.—The examination should be made at the school and the clinical work may be done either at the school or at some building of the Health Department. This work requires special conveniences and equipment. The chart on page 318 shows the floor plan and arrangement of the medical inspector's room in general use in New York City.

These quarters should be centrally located, preferably on the ground floor, and should have the essentials of a waiting room, proper lighting, an electrically lighted chart and distance of 20 or at least 15 feet for eye examination, a lavatory and table with the necessary filing cabinets for records. The diagram shows a convenient arrangement by which the waiting room space may be used in eye examinations so that a room 12 by 20 feet is made sufficient. In cases where the room is not in constant use it may be used on alternate days as a clinic. In this case the room should be somewhat larger and might contain as a complete equipment: a desk, wardrobe, medicine cabinet, two chairs, couch, lavatory, scales with measuring rod, electrically lighted vision chart, portable screen and a filing cabinet with the medical and surgical supplies in most common use such as cotton, gauze, bandages (1 and 2 inch), boracic acid, green soap, collodion, tincture of

iodine, sulphur ointment, white precipitate ointment, vaseline, peroxide, lysol, aromatic spirits of ammonia, hand scrub, tongue depressors, toothpicks, argyrol, cocaine, bichloride of mercury, atropine, alloy, bluestone, yellow oxide of mercury, and nitrate of silver.

The Correction of Defects.—When the physical defects have been discovered, a card somewhat like that shown on page 319 is usually sent to the parent.

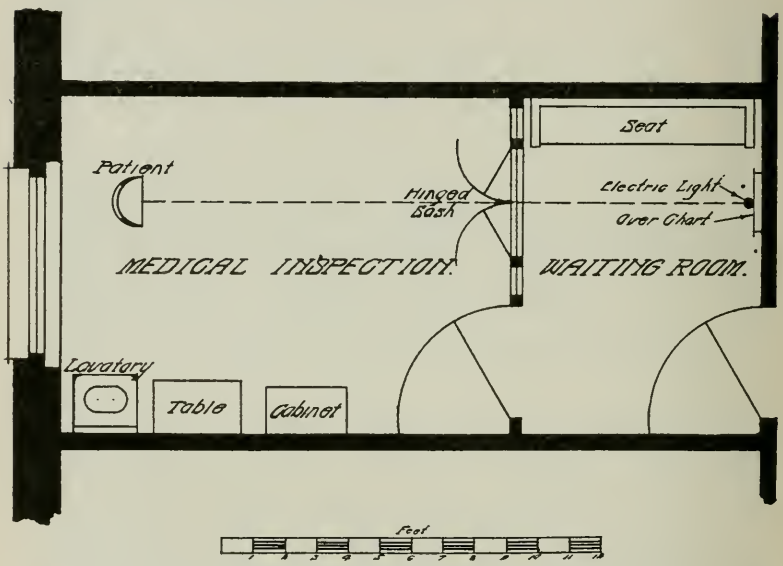


Fig. 54.—Floor plan and arrangement of medical inspector's room generally followed in New York City. By the arrangements indicated, the width of the waiting room may be used in eye examinations and a space 12 by 20 feet is sufficient for both waiting room and examining room. (After Berkowitz.)

The school nurse enters the home and endeavors to secure the cooperation of the family in having the children cared for by the family physician or dentist. If circumstances do not permit this, the nurse assists in securing medical aid from a free public clinic. These clinics may be in connection with a large hospital or they may be operated by the health department or the school department. Seven

types of special clinics are commonly found and are for the treatment of dental, ocular, nutritional, postural, heart, tonsil, and tubercular defects, respectively. In some instances general clinics are provided for treatment of all school children either free or at a nominal cost; but in general, clinics are provided only for children whose parents cannot pay for treatment at the hands of their private physician or dentist.

Defective Vision.—Defects of vision quite unnoted by parents or teachers may transform an otherwise normal, wholesome child into a dull, "headachy," apathetic laggard. He

Office Medical Inspector of Schools

....
Parent or Guardian Address

A recent physical inspection of.....
Name of child

attending the ..... indicates the following
Name of school

abnormal conditions:

.....

You are advised to take ..... to your
Name of child

family physician, dentist, oculist, or to a dispensary for advice and treatment.

.....
Medical Inspector.

finds it impossible to keep up with his classes, becomes indifferent, depressed, discouraged, and wonders how it all came about. Another child may be sensitive, irritable, and high strung. He works under constant strain and does his futile best. From both of these classes are recruited some of the girls and boys who soon weary of school and, misunderstood, they become difficult children.

The schools themselves may be responsible for a definite amount of deterioration due to improper placing of pupils in relation to window and blackboard and by failure to have pupils' eyes tested periodically by a skilled person. Schools for children with impaired vision pay meticulous

heed to the details of conserving, developing and strengthening such remnants of vision as the child possesses. Institutions for the blind bear witness to the tragedy of neglecting early cases of defective vision.

Fig. 55.—The effect of treatment for adenoids upon the general appearance of three children. The upper picture was taken before treatment; the lower, after treatment.

Special attention must be given to the conservation of vision and the correction of visual defects. The accompanying diagram shows the physical basis of far-sightedness and near-sightedness as compared with normal sight. In normal sight (emmetropia) the image is sharply focused on the retina. In far sight (hypermetropia) the eye ball is too shallow and the perfect focus of the image would take place behind the retina. There is therefore a blurred image and in-

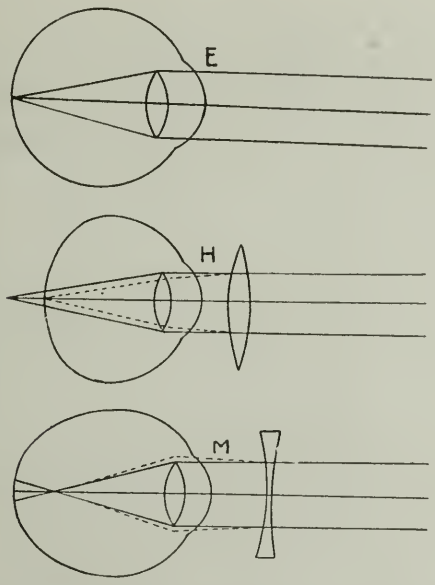


Fig. 56.—Errors in refraction; *E* shows the formation of the image on the retina in the normal or emmetropic eye; *H* shows the condition in long-sight, or hypermetropia, where the eyeball is too short; *M* shows the condition in short-sight, or myopia, where the eyeball is too long. (Pearce-Macleod.)

distinct vision. Hypermetropia is more commonly found in young children and many of these cases tend to correct themselves. However, all cases where eye strain is involved should receive treatment.

In near sight (myopia) the eye ball is too deep and the image is focused in front of the retina. Myopia is a more

common defect among older children; it is a more serious condition and should not remain untreated. The amount of myopia increases where there is less occasion to use distant vision. City children have been shown to have more near-sightedness than country children. The schools themselves may be responsible for some degree of deterioration of vision. This is especially true if the student holds his work too close to the eye. There are many factors which may induce near or strained vision such as insufficient light, light from the wrong direction, a strong light in front of the eyes, faulty position of the pupil in relation to the blackboard, faulty illumination of the blackboard producing shiny surfaces, faulty desks and seats leading to bad postures and bending of the head, and the condition of the child's general health.

Astigmatism is a defect of a different type. In some cases it is of little consequence if no symptoms are produced by it. On the other hand, it may be a very serious defect which of itself is the cause of "eyestrain" with the accompanying headaches and poor health. This is a condition which calls for accurate and careful correction. There are different kinds of astigmatism, according as the eye is, in the vertical and horizontal meridians respectively, hypermetropic, or myopic. In what is known as mixed astigmatism, there is hypermetropia in one meridian and myopia in the other.

Defective Hearing.—Schools have often failed to give sufficient attention to defective hearing. From 13 to 25 per cent of school children have hearing which is subnormal. Defects of hearing are either congenital or acquired. The latter group of conditions arise from the infectious diseases of childhood, from diseases of the ear, from nervous diseases, and from injury. Kerr states that "probably at least half the cases of all forms of deafness are preventable. If subnormal hearing in ordinary schools is reckoned, then 80 per cent should be preventable. If only half the cases due to measles, and half to scarlatina, and those due to neg-

lected adenoids, was prevented, it would reduce by one-third the numbers in London.''

Children who are completely deaf are taught in special schools. An important need at the present time is the detection of those children who are hard of hearing, in order that corrective treatment may be undertaken promptly where possible, and in order that children may be taught lip reading when this is desirable. Many school systems

Fig. 57.—Giving hearing test by means of the 4A Audiometer. This picture shows the front of a classroom in which the whole class was being tested at one time. (Courtesy of Mr. DuBois, Principal, Williams School, Chelsea, Mass.)

require the annual testing of hearing by the teacher. The tests which have been used in the past are the whispered voice or the determination of the distance from the ear at which the pupil can hear a watch ticking. These methods are difficult to standardize and in other respects our experience in the testing of hearing has not been at all satisfac-

tory. A new device for testing hearing, the audiometer, is shown in the accompanying illustration. It is, in effect, a sort of phonograph. The children listen to the record through a rubber tube. The record consists of a series of numbers, the first numbers being spoken loudly and succeeding numbers being spoken more and more faintly. The child is given a sheet with blank spaces for the numbers. This sheet contains the following instruction to the pupils: "You will hear numbers spoken by a person who is moving away from you. The voice will get weaker and weaker. Listen carefully and write as many numbers as you can." Forty children may be tested at once and it is easy to determine the hearing loss by locating on the record sheet the point at which the child fails to discern the numbers. This instrument has proved of definite value in locating missed cases. There are modifications of the method used and there is also a slightly different type of instrument for the further testing of individual children.

The Dental Care of School Children.—No more conclusive proof of the importance of the dental care of school children can be cited than to describe the experience of cities where school hygiene has been practiced extensively. The work at Bridgeport, Conn., is the successfully developed program of Dr. Alfred C. Fones and it merits careful consideration. The total number of children examined and treated in the first and second grades the first year was 6,768. On the first examination less than ten per cent were brushing their teeth daily. About thirty per cent claimed that they brushed their teeth occasionally, while sixty per cent were frank enough to state that they did not use a toothbrush. Ten per cent of the children were found to have fistulas on the gums, showing the outlets of abscesses from the roots of decayed teeth, and they averaged over seven cavities per child. "It was shocking," writes Dr. Fones, "to find the mouths of these children five to seven years of age in this deplorable condition, and it was appalling to contemplate the conditions that would

Fig. 58.—Dental Clinic at the Forsyth Dental Infirmary for Children, Boston, Mass.

exist in these mouths as the children grew up. It presented very interesting material to work with."

Dr. Fones in beginning his work in Bridgeport examined the mouths of the children of the fifth grade. These children had never received any dental attention. Five years later he again examined the mouths of children of the fifth grade, this being the first class to have received dental care upon entering school. The beneficial results of his work are shown by comparative figures. There was a reduction of caries in the permanent teeth of the fifth graders amounting to 33.9 per cent. This reduction was due in the main to three activities, (1) cleaning the teeth, (2) filling the six-year molars, and (3) teaching prophylaxis and the use of the toothbrush.

The health education outlines of the city of Cleveland, Ohio, describe the splendid dental service in their school system as consisting of:

A. The examination of the teeth of all children from kindergarten to sixth grade, inclusive, once a year by graduate dentists.

B. The care of all faulty first permanent molars in the mouths of six-year-old children in the schools in which there is mouth hygiene equipment.

C. Annual prophylactic treatment (cleaning the teeth) for each child, kindergarten to sixth grade, inclusive, in the schools in which there is mouth hygiene equipment.

D. Escorting children to the hospital for the extraction of infected teeth under an anesthetic, when parents cannot be induced to attend to this parental obligation.

E. Referring children to private practitioners of dentistry whenever service is needed, kindergarten to sixth grade inclusive.

Medical Service.—Perhaps the best way to describe the medical activities in school hygiene is to cite the example of a city which has developed a good system of medical inspec-

tion. The city of Detroit, Michigan, which has a population of 900,000 and a school population of 130,000, has perfected a division of school medical inspection under the Department of Health.

Records show that communicable diseases among school children are decreasing from year to year. The department has established a routine procedure for the prompt detection of infectious diseases, for exclusion of cases from school under proper quarantine and treatment and for the prompt return of the pupils to school after the quarantine is lifted. School inspection is done under the medical director who has in charge 50 medical inspectors. These inspectors visit from three to five schools every school day working from 9:00 A.M. to noon. Standing orders have been issued to all teachers by the Board of Education through the agency of the Department of Health to send promptly to the examining room all pupils coming under the following heads: (1) children who were absent on the previous day, (2) children who have a skin eruption or rash, (3) children having sore throat or fever, (4) children having persistent cough or sore throat.

In Detroit the nurse arrives at the school in advance of the medical inspector, and does the nonmedical work, being able to eliminate some of the pupils sent down to her for possible exclusion from school. All children having returned to school after an absence are questioned and on the average two out of every ten questioned are excluded.

For instance, Johnny tells the nurse that he was absent because he had a sore throat. In answer to further questions Johnny informs the nurse that his mother and two other members of the family are suffering from sore throat. The nurse takes a culture and Johnny is sent home. Later in the day she visits Johnny's home for the purpose of making a more extensive survey. If her suspicions are aroused she telephones to the Department of Health and a diagnostician is sent to the house. If a true case is found immediate measures are taken to quarantine the family.

The children are arranged in groups for the attention of the medical inspector, so that he finds them in the examining

room each with a card properly made out. The children with sore throats are in one group, those with skin rashes in another, etc. The medical inspector takes up the work of the nurse making a diagnosis and giving to the principal a list of the children to be sent home. It is Dr. Vaughan's practice to recognize the presence of two cases of a communicable disease in the same school in one week as an incipient epidemic, in which case the inspector makes an examination or takes a culture of every child in the school.

Special Groups of Defectives.—School authorities keenly realize the difficulties in educational progress caused by the special physical, mental and temperamental disabilities from which certain children suffer. These children have defects which make it desirable and in some cases imperative, both for their own good and in justice to the other pupils, that their education be conducted in special classes apart from the public school. Such defectives have been divided into the following eight classes: (Crowley's *Hygiene of School Life.*)

1. Nervous children.
2. Backward children, consisting of two main subdivisions:
   (a) Dull children whose backwardness is due to some accidental cause.
   (b) Dull children with inherent diminished capacity for book learning.
3. Mentally defective children:
   (a) Feeble-minded.
   (b) Imbeciles and idiots.
4. Children with defective vision or blindness.
5. Children with defective hearing, deafness or deaf mutism.
6. Physically defective children, including cripples.
7. Epileptic children.
8. Children suffering from a combination of physical and mental defects, e.g., the blind idiot, the feeble-minded deaf child.

Obviously, the education of these children is a health problem as well as an educational problem, and medical service is necessary in handling the problem of special classes.

Special Health Classes.—The groups of children having the more serious defects enumerated above are taken care of in special schools or institutions outside the public school system. Contrasted with these, we find certain special classes as a part of the public schools where classroom instruction is provided for groups of children selected on the basis of some less serious defect. Two types of such classes may be mentioned.

Open air classes are advocated for debilitated children who are anemic, glandular or under size and for children with heart lesions showing broken compensation whose disease is not serious enough to prevent school attendance. A temperature of approximately 55° F. is maintained in these rooms. Mid-morning luncheon is served. Resting chairs and blankets or sleeping bags are provided and a regular rest period is an order of the day. The amount of school work is adjusted to the physical strength of the child. There is a physical examination upon entrance.

Rest and Nutrition Classes constitute a modification of the basic ideas behind the open air class. It is recognized that rest and nutrition are the two most important needs of the type of children concerned and obviously all schoolrooms should have fresh air provided by suitable ventilation systems. It seem practicable, therefore, to select debilitated children and to provide them with extra rest and nutrition without removing them entirely from the regular classroom. These children leave the regular classroom fifteen or twenty minutes before the morning recess. They go to a rest room where they lie down for twenty minutes, after which they receive a light lunch and spend the last few minutes of the recess period with the other children. They stay at school during the noon hour, receiving their lunch there, and having another period of prone relaxation. Another light lunch is provided for these children in the middle of the afternoon. This program is much less expensive than the conduct of big open air classes, and it lends itself much more

readily to the handling of children from several different grades, since each child remains with his own class for instruction. Good results are reported from this type of class.

Sight conservation classes are provided for children of ⅓ to 1/10 normal vision. Such a classroom is properly lighted, equipped with movable and adjustable desks, unglazed paper, soft pencils, readers with large print (24 point) on yellow tinted paper. Study is alternated with manual work or exercise. The children are given as much school instruction as is compatible with the retention or improvement of their powers of vision and at the same time are taught the conservation of their own sight.

3. HEALTH PROMOTION

Only recently have the schools made definite health promotion a real and serious part of the health program. It is not enough to realize that we must depend upon personal hygiene rather than sanitation or preventive medicine for extensive reduction in the amount of certain diseases like tuberculosis. Instruction in personal hygiene from that point of view is likely to be morbid, flat, stale and unprofitable. A most important task of the public school is the maintenance and promotion of vigorous health among the great group of children. The principles of such a program are set forth in the following quotation from the report of the Committee on School Health Program of the American Public Health Association.

"*a. Hygienic Arrangement of the Daily Program.*—There should be such an arrangement of the daily program as to secure the most favorable conditions for activity, by a suitable alternation of study with work and play, of the use of the large with that of the small muscles, of activity with rest periods, of indoor with outdoor activities. Short relaxation periods between classes are indicated when the exigencies of the school program prevent the suitable alternation mentioned above.

"Hot school lunches should be available for all pupils who are unable to get home regularly during the noon intermission. It is equally necessary that the child should have a suitable breakfast before coming to school.

"The number of hours per day which shall be required of the child in a properly regulated school program should be graded according to the age, and the mental and physical resistance of the child.

"The basis for admission and promotion should be the physical and psychological condition of the child rather than the chronological age alone.

"*b. Physical Activities.*—At least 180 minutes per week should be available for vigorous physical exercise. The type of exercise should call into play vigorously the large fundamental groups of the big muscles. These exercises should be supplemented by others to bring into play the finer muscles of coordination. Games should be so conducted as to develop alertness, cheerfulness, and fairness. Special attention should be given to the development of habits of good posture. School credit should be given for physical activities.

"*c. Health Instruction and Motivation.*—The goals of health instruction are to establish health habits, to give the child a practical knowledge of the principles of healthful living, to develop health ideals, and to arouse a sense of individual responsibility for the health of the community, and community responsibility for the health of the individual.

"A sanitary school environment and a proper attitude on the part of the teacher are constant features in developing suitable health attitudes on the part of the child.

"The content of health instruction must vary with the age and grade. In the kindergarten and lower four grades, the chief effort should be to develop health habits mainly by inspections and special devices.

"In subsequent grades systematic instruction should attempt to crystallize and fix the health habits which have been taught heretofore, and to provide the pupil with necessary information concerning the physiologic basis for healthful living, the principles of bacteriological cleanliness, and the sanitation of the community. The teaching of first aid and simple facts about home nursing should be included in the instruction program. The care of the teeth should be taught by instruction and by toothbrush drills. The importance of mental hygiene should not be forgotten.

"The work of each grade should be so planned that the necessary repetition of facts will not be dull, and that new material shall be presented in each grade. The positive conception of health, rather than the negative conception of disease, should always be emphasized when possible.

"Satisfactory results are impossible unless interest and enthusiasm are maintained. The use of special devices and activities is necessary to achieve that end. These include such things as health inspections, experiments, illustrations, dramatization, songs, the making of scrapbooks, contests, child organizations, and the keeping of health habit score cards."

Health Education.—The rapid spread of Health Education has been one of the most significant public health movements of modern times. It has resulted in placing hundreds of thousands of children in the school system under a systematic program of habit training in the simple, fundamental health procedures. One set of these specific rules has been widely used by the American Child Health Association under the title of "The Rules of the Game." These "rules" are as follows:

1. A full bath more than once a week.
2. Brushing the teeth at least once every day.
3. Sleeping long hours with windows open.

4. Drinking as much milk as possible and as little coffee or tea.
5. Eating some vegetables or fruit every day.
6. Drinking at least four glasses of water a day.
7. Walking or playing a part of every day out of doors.
8. A bowel movement every morning.

A set of Health Chores somewhat more extensive in nature and issued by the National Tuberculosis Association has been widely used in the Health Crusade, which has been developed as a method of health habit training.

The scope of the health training program is indicated in the following list of general health rules which make up the "decalogue of health" in the Cleveland Health Education Outline:

1. Keep the body clean.
2. Eat the right amount of wholesome food.
3. Get enough sleep and rest.
4. Keep the body erect.
5. Play and exercise properly.
6. Keep your school, home, and neighborhood as healthful as possible.
7. Keep a healthy mind.
8. Prevent accidents.
9. Avoid communicable diseases.
10. Know your own physical limitations and live within them.

For purposes of health training in the public school it is necessary, of course, to break down these general commandments into a long series of detailed health practices which may be encouraged according to the age, needs, and responsibilities of the children.

The present tendency is to organize thoroughly, systematically and completely the health education program for each grade in the school system, using a variety of meth-

ods adapted to the age interests of the child. The room teacher is recognized as the most important factor in this training program. She must naturally look to the physician, dentist, nurse, physical educator, nutrition worker or other health specialist for advice and assistance. In many cities, the definite responsibility for the development and maintenance of the health education program has been placed upon some one individual who by training and experience possesses an adequate knowledge of health maintenance and educational method.

Certain routine procedures are usually organized to contribute to the modern health education program. These include: (1) the regular weighing and measuring of children in order to interest them in growing and thereby stimulate them to the development and maintenance of those habits which promote growth; (2) the every-morning-health review, or morning inspection at which time children are inspected for cleanliness, for the maintenance of other health habits which can be checked by direct observation, and for early signs of communicable disease; (3) the mid-morning milk lunch which is used quite as much for its educational opportunities as for purposes of extra feeding, and (4) regular relaxation periods which provide an opportunity for children to break long periods of study by standing up to stretch or by going through simple exercise while facing the open window. Health is correlated with other subjects both incidentally, as other classes are being held, and in long teaching units through which several subjects of instruction are combined in a single class project. The regular hygiene period is used, not only for purposes of presenting information, but also for the purpose of organizing the general health training program.

The value of such a health training program in schools is beyond question. Studies carried on by the Massachusetts Institute of Technology and the Malden Public Schools,

under the direction of the author,* have demonstrated definitely beneficial results. Not only was such a program practicable and highly acceptable to pupils, teachers, and parents—it was also shown to have had sufficient effect upon the lives of the pupils so that habits were definitely improved to such an extent that children with a health education program showed a better growth rate than did children of a control group who were not receiving special health training.

Physical Education.—A word may well be said concerning the place of physical education in the school health program. This phase of school work has both health and educational objectives. Leaders in the profession regard the following as the aims of the physical education program: (1) to provide relaxation in the school day, (2) to establish a fondness for big muscle activities and habits of regular exercise, (3) to develop special skills, (4) to correct marked defects of posture through work with individual children, (5) to contribute to mental health, personality, and character.

It is obvious that physical activities contribute to health directly and that the desire to succeed in physical accomplishment is a stimulus toward the development of health habits. However, the educational values of physical education are so important that the program would be worth while even if it did not make its important contribution to health.

Standards.—Suggestions of various authorities would indicate the following standard requirements for a school health program:

1. Proper location, construction, hygiene and sanitation of schoolhouses; adequate room space—no overcrowding.

*These studies have been reported in the American Journal of Public Health as follows:
"Malden Studies in Health Education, A Preliminary Report," May, 1925.
"Malden Studies on Health Education and Growth," October, 1928.
"Precision and Reliability of Underweight Measurement," September, 1929.

2. Adequate playground and recreational facilities; physical training, and supervised recreation.

3. Open-air or rest and nutrition classes for pretubercular and debilitated children.

4. A sufficient number of full time school nurses to assist physicians, to make home visits to advise and instruct mothers in principles of hygiene, nutrition, and selection of family diet, and to take children to clinics with permission of parents.

5. Adequate space and equipment for school medical work and available laboratory service.

6. Part-time physician with one full-time nurse for not more than 2,000 children, or full-time physician with two full-time nurses for 4,000 children for:

(a) Complete periodic physical examinations with determination of weight and height at beginning and end of each school year; monthly weighing wherever possible.

(b) Continuous health record for each child to be kept on file with other records of the pupil. This should be a continuation of the preschool health record which should accompany the child to school.

(c) Special examinations to be made of children referred by teacher or nurse.

(d) Supervision to control communicable disease.

(e) Recommendation of treatment for all remediable defects, diseases, deformities, and cases of malnutrition.

(f) Follow-up work by nurse to see that physician's recommendations are carried out.

7. Available clinics for dentistry, nose, throat, eye, ear, skin, and orthopedic work; and for free immunization against diphtheria, smallpox and typhoid.

8. The maintenance of midmorning lunch or hot noonday meal when necessary.

9. Examination by psychiatrist of all atypical or retarded children.

10. Education of school child in health essentials. There should be provision for weighing and measuring children in order that they may become interested in their own growth.

11. General educational work in health and hygiene, including education of parent and teacher, to secure full cooperation in health program.

CHAPTER XVII

INDUSTRIAL HYGIENE

The health of the worker is a fundamental national problem. The great majority of our vast population belong to the group of workers, and the social and economic aspects of the question are interrelated with health conditions. Upon the contentedness of the industrial classes and upon their physical well-being rests the stability of our social system. The craftsman of the Middle Ages with an interest in the technique of his work amounting to the professional pride of any generation, no longer exists. The skill of the hand has been supplanted by the precision of the machine. This change is fundamental, for the laborer no longer secures much of his enjoyment of life from his work but endeavors rather to earn enough to be able to purchase his amusement out of working hours. This important and unfortunate change has deprived the worker, in most cases, of a pride in his occupation and centered his mind so completely upon the financial return that he is not as interested as he should be in the conditions under which he works. To be sure labor of late has, in many cases, demanded better working conditions; but more instances can be found where laborers used unhygienic conditions as a basis of the demand for more wages and not as a basis for demanding better health conditions.

In the Middle Ages the craftsman had joy and pride in his work akin to that of the surgeon or the dentist who is continually improving his skill and technique. The old Guilds maintained a form of accident and sickness insurance; they appointed inspectors to see that the work was properly done and honest labor was their watchword. The craftsman knew the entire process of making the article on which he was working and he knew that his return would be proportional to his

endeavor. The broad interests and the social organization of the Trade Guilds reached a height to which the existing labor unions have not attained.

We are probably moving toward a condition of cooperation in industry, but under present conditions it is most difficult to give the workman the old time interest in what he is doing. He knows only a bit of the process of manufacture, the industry is so large that he is widely removed from the man at its head; there is in many cases worse than a lack of sympathy between employer and employee, and the high labor turnover testifies to the lack of interest of the workman in his particular factory. The return of the worker's interest in his work and in the conditions of labor would greatly aid the progress of the health movement. But the latter movement need not be delayed for the former, for its solution will help to solve the economic problem.

This unfortunate industrial condition of class selfishness in which labor and capital with mutual dislike and distrust both profiteer to such an extent that unskilled or semi-skilled labor receives more money than the average man in the professions, while capital merely adds the cost of increased wages to the sales prices and thereby increases both the value of its property and the rate of its return, is unfortunate from the *economic* point of view. But industrial distrust in place of industrial cooperation is even more objectionable from the viewpoint of health.

In the past, labor unions have sometimes objected to physical examinations. The reasons given were that physical examinations give an industry the opportunity to spread propaganda favorable to capital among its workers; that there is an opportunity for the industry to discharge "labor" men by declaring them physically unfit; that the bodies of the men are their own and that capital has no right to have an inspection; that the physician who is examining the men will testify against them in court if they have a case against the company for industrial accident; that industries try to secure the good-

will of the general public by expanding the health work for employees.

Physical examinations are now coming to be recognized and accepted, along with other industrial health services, as a proper part of the relationship between the employer and the employee. The farmer has always been concerned with the maintenance of the health and welfare of his hired man. Health service in industry involves exactly the same principle. It is certainly beneficial to the industrial worker to have help in maintaining his physical condition. Such a service is beneficial to the employer because a healthy worker, free from bodily defects and therefore more efficient and contented, is more profitable to the industry than the same man encumbered with bodily defects with which he frequently seeks employment. The organization and use of industrial medical and health service is a natural adaptation of public health science to modern social conditions.

General Problems.—There are many considerations in the regulation of industry which apply to industries generally and which are regulated both from without by the state and from within by the industrial management and the demands of organized labor. There are such problems as the hours of work, fatigue, child labor and women in industry. These questions with their interrelationships have such a universal application that it is the duty of the state, first, to study by observation and research the conditions of employment; second, by careful legislation to regulate conditions in a sane and practical manner and, third, to enforce the law by an efficient organization for factory inspection.

Hours of Work.—The number of hours which an individual may work depends largely upon the nature of this work. If labor were interested in maximum production, it might be possible to arrange for each occupation the hours of labor in accordance with greatest efficiency without injuring the health of the worker. So far as the state is concerned, how-

ever, it must deal with industries in large groups and set standards of labor in terms of hours per week beyond which either health or production or both are likely to suffer.

The experiences of the great allied countries during the war have taught us much in this regard and the investigations begun under war conditions are likely to be continued, greatly to the profit of industry. These reports* show a reduction in hourly output during the later hours of the 8, 10, and 12 hour working day, the reduction being greatest in the last instance. The relative benefits of a ten minute rest period in the eight or ten hour day and the great advantages of Sunday rest are described. Perhaps no more striking fact was brought out than the discovery that the weekly production on the six day basis was equal to or greater than the weekly production on a seven day basis.

Fatigue.—Industrial efficiency demands that unnecessary fatigue shall be reduced to a minimum. There is a normal fatigue which is induced by the day's work and dispelled by the night's rest. There is also an accumulative fatigue which increases from day to day throughout the working week and which *may* not be dispelled by Sunday rest. The fatigue may be either muscular or mental. The body recovers more rapidly from the former than from the latter. As the fatigue of the working force increases, there is a reduction in output, an increase in lost time, an increase in the amount of wastage in the manufacturing process, and an increase in the number of accidents.

There are six important contributory influences which induce fatigue,—three are outside the industry and three are inside the industry. First, if the *housing* or living conditions of the worker are poor, he may not have suitable opportunities for rest. Second, the *transportation* to and from the factory may be an additional source of fatigue. Third, the *habits of living* may preclude suitable recreation

Report of the Health of Munition Workers, Committee of the Ministry of Munitions, published by His Majesty's Stationery Office, London, 1918.

and the maintenance of physical fitness. Fourth, if the *hours of work* are too long, fatigue increases from day to day. Dr. Vernon cites an example (*Health of Munition Worker's Committee.* Memo. No. 18) of a group of workers who were sizing fuse bodies and were given a reduction of hours at this heavy task amounting to 12 per cent with the result that the output rose 22 per cent. Fifth, the *conditions of employment* also affect fatigue. Poor ventilation, the necessity of working in a room of high temperature, and poor lighting are particularly important. Sixth, the *methods of work* are also involved. Experiments have shown that in several occupations a man will do more work by a definitely planned alternation of work and rest periods than by attempting to work continuously. Waste motion can often be eliminated; and in some occupations a definite rhythm of movement may be introduced which will lessen fatigue. The control of these conditions means better health for the industrial worker and greater return for the industry.

Child Labor.—Many states already have good laws prohibiting the employment of child labor, but even the best of these states have inadequate machinery for inspection and enforcement. The unrestricted employment of children in industry interferes with their physical and mental development, and moreover, children have been found to be subject to industrial accident and industrial diseases to a greater degree than adults.

Women in Industry.—Special legislation is frequently necessary to safeguard the health of women because they lack strength for undertaking many occupations, and in addition there is a period each month during menstruation and a longer period at the termination of labor when heavy employment should not be allowed. Most states require that a woman shall cease work from two to four weeks before labor and that she shall not recommence work until four weeks after the birth of the child. Infant mortality increases with the proportion of women working outside the home. Women lose

more time because of sickness than men. In properly organizing the industrial employment of women, attention must be given to their strength limitations, their limits of physical endurance, the possible necessity of work at home outside of factory hours, nutritional and physiological peculiarities.

Factory Inspection.—Factory inspection involves the enforcement of laws regulating ventilation, dusts, gases, odors, temperature, moisture, light, cleanliness, overcrowding, water supply, washing facilities, water closets, lockers, fire prevention, the safeguarding of machinery, first aid facilities, hours of labor, employment of women and children, ages of employment, etc. In many states the enforcement of these laws is under the State Department of Health and enforcement is a reasonable duty of the Division of Industrial Hygiene. In other states, however, it is under a separate Department of Labor and Industries but when so located it demands much attention from the medical viewpoint, especially in these times when so much is being learned regarding poisons and other industrial hazards. No state can be excused for not investigating and trying to lessen the health and accident hazards of the industries within its borders.

Industrial Accident Insurance.—The history of Employers' Liability Acts which originated in Europe and which were later supplanted both in Europe and America by industrial insurance describes a step forward in industrial relations. Under Employers' Liability the workman recovered damages for injury by accident by bringing suit against the employer and it was necessary for him to prove that the accident was due to the fault or negligence of the employer rather than to his own fault or that of a fellow worker. Naturally ill will arose between the contending parties; the amount of damages granted often depended upon the case and the court rather than upon the extent of the injury; and there was usually a long delay before the stricken family of the injured worker received any benefit.

Society has gradually come to assume that the industry is responsible for all accidents occurring in its processes and that the workman should be paid promptly and in proportion to the injury or incapacitation incurred in the execution of his duties as an employee. Accordingly most of our states have now enacted industrial insurance acts under which the employer insures his liability with the state or with an independent insurance company. Under such a law the employee receives benefits from any accident incurred in the industry and from diseases contracted because of occupation. It is not necessary for the workman to prove that the accident was the fault of the employer since no difference is made between payment in such accidents and in those due to the fault of the worker, unless malicious or intentional. Under this system the workman receives compensation after a waiting period of about ten days; there is no delay or expenditure for court procedure, and the friction between employer and workman is banished.

HEALTH ADMINISTRATION IN INDUSTRY

Health activities in industry are usually carried on under a service department and under the administration of a Service Manager who reports directly to the General Manager. The chart on page 344 and 345 used with permission of the Hood Rubber Company gives the organization and activities of one of the most complete and successful service departments in the country.

In industries where the service department has been given a fair trial under tactful and efficient leadership, it has clearly demonstrated its usefulness and both employers and employees have come to regard it as a normal and natural service which the manufacturer should render to the workman under the conditions of his employment. More than that it gives opportunity for the employee to better his own conditions and those of his fellow workers, thus making a job into

ORGANIZATION AND FUNCTIONS OF SERVICE DEPARTMENT.

SERVICE MANAGER.

FUNCTION
of Service Department:
TO CREATE AN EFFICIENT, HEALTHY, STABLE BODY OF WORKMEN

EMPLOYMENT.	HEALTH.	SAFETY AND SANITATION.	EDUCATION.	GENERAL SERVICE.
FUNCTIONS	FUNCTIONS	FUNCTIONS	FUNCTIONS	FUNCTIONS
1. Knowledge of Sources of Supply.	1. Physical examination of Applicants.	1. Reduction of accidents by—	1. Bulletin Board information.	1. Supply Store for Employees. (Groceries sold at cost.)
2. Knowledge of Factory Requirements.	2. Physical examination of present employees.	(a) Education.	2. General instructions to employees.	2. Farm. (Vegetables raised and sold at cost.)
3. Knowledge of Hours of Work.	3. Periodic reexamination of defectives.	(b) Safeguarding Hazards.	3. Circulation of current Magazines.	3. †Restaurant Service.
4. Knowledge of Wages.	4. Periodic reexamination of employees exposed to Industrial Hazards.	(c) Following up of accidents and near accidents.	4. Circulation of Library Books.	4. Supervision of Housing.
5. Knowledge of Work Environment.	5. Advise Employment Dept. on placement of defectives.	2. Frequent Factory inspection, by—	5. Instructions in—	5. Supervision of Recreational Activities.
6. Proper selection of applicants by—	6. Treatment of Medical cases.	(a) Safety Engineer.	(a) Health.	6. Supervision of Benefit Plan covering Sickness, Accident and Death.
(a) Careful Interview.	7. Treatment of Surgical and Accident cases.	(b) Members of Safety Committee.	(b) Hygiene.	7. Supervision of superannuated employees.
(b) Knowledge of past record.	8. Treatment of Dental cases.	3. Report all Accidents to proper authorities.	(c) Care of teeth.	8. Supervision of Thrift Activities.
(c) Knowledge of Physical Condition.		4. Cooperate with Employment and Health Departments in shorten-	(d) Care of eyes.	
(d) Knowledge of job requirements.			6. Factory Publication.	
			7. Organization clubs.	
			8. Americanization Campaign.	

7. General instructions to new employees.
8. Follow up of Service Record.
9. Investigation of Absences.
10. Transfers and Promotions.
11. Investigating of Grievances.
12. Interview all leaving employees.
    (a) To approve discharge.
    (b) To check up foreman's reason for leaving.
    (c) To insure an impartial hearing.
13. Keep adequate individual records.
14. Keep detailed turnover records.
15. Furnish State and Federal records.
16. To act as clearing house for general Employment Work.

9. Treatment of Ocular cases.
10. Prevention of a communicable diseases and epidemics.
11. Cooperation with Employment Dept. and Safety Dept. in investigating absences.
12. Furnishing Employment Dept. with data concerning employees who are leaving on account of ill health.
13. Keep adequate examination and treatment records.
14. Furnish statistics pertaining to Health.

ing periods of disability.
5. Facilitate compensation payments.
6. Keep adequate records and statistics.
7. Supervision of—
    (a) Drinking water.
    (b) Ventilation.
    (c) Lighting.
    (d) Heating.
    (e) Toilets and Locker rooms.
    (f) Janitor and matron service.
    (g) General sanitary conditions.
8. Elimination of industrial disease hazards.
9. General supervision of working conditions.

9. Legal advice to employees.

†Not under Service Organization.

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a career and a mechanical operation into a human relationship. It is a new and proper service from the manufacturer which is bound to develop as has accident insurance and which will soon cease to be resented as "charity" by the workman, provided of course that it is properly administered.

The activities of the service department are seen to be numerous and varied. The service manager must first of all be a good administrator; he must know the industry; he must understand men and he should be familiar with the facts concerning health and sanitation and the principles of health administration. He may be a sanitarian or a physician by training but in any case he is, in a large organization, an administrator and can secure expert services and delegate either the medical or engineering responsibility.

It does not lie within the scope of this volume to describe the multiple activities of a service department. The number undertaken and the details of administration vary widely. The reader is not interested in the strictly medical and dental phases and the discussion will be limited accordingly. We shall provide such comment upon accident prevention and sanitation as will show the close relationship which they bear to health improvement.

Accident Prevention.—Scientific accident prevention has been adopted by nearly all of the great industries where hazards are numerous and it has succeeded because it is practical. It has been demonstrated that by properly safeguarding machinery and dangerous processes and by organizing the men for safety, the number of accidents can be markedly reduced. Accident rates have been reduced 80 per cent in some industries and it is estimated that 25 per cent of this reduction was due to mechanical safeguards and 75 per cent to thoughtful precautions taken by the men themselves as a result of "Safety First" teachings. This reduces the suffering of the men, makes the work more desirable and it reduces the expenses of insurance and medical attendance.

Safety engineers have often been men without an engineering training but men of good mixing ability who understood the industry and who were able to organize the men into safety committees and follow up accidents to see that the proper remedies were applied for dangerous conditions. It has happened frequently that safety engineers have also been interested in the sanitation of the plant and sometimes to an even broader extent in the health of the men. It is often desirable that a man should be secured for this work whose training enables him to combine sanitation and safety.

DAYS LOST FROM ACCIDENTS REPORTED TO THE BUREAU OF WORKMEN'S COMPENSATION, JANUARY TO SEPTEMBER INCLUSIVE

CAUSE	DAYS LOST
Machinery	861,887
Boilers	32,115
Pumps, Compressors and Prime Movers	41,094
Transmission	101,061
Elevators	234,224
Cranes and Derricks	429,359
Cars and Engines	2,405,189
Motor Vehicles	629,827
Horse Vehicles	137,093
Hand Trucks	116,434
Water Craft	49,469
Handling Objects	711,906
Hand Tools	372,285
Electricity	342,352
Explosives and Explosions	1,161,582
Hot and Corrosive Substances	469,938
Falling Objects	595,857
Falling Objects (Mines and Quarries)	2,206,004
Fall of Persons	1,026,587
Stepping upon or Striking Against Objects	179,553
Miscellaneous Causes	665,009
Total	12,768,825

The table presented herewith gives an indication of the relative frequency of different types of accident and the tremendous cost involved. These figures were published by

the Department of Labor and Industry of the Commonwealth of Pennsylvania. They indicate the amount of lost time from accidents occurring over a nine months' period. The amount of lost time is estimated according to the scale of time losses approved by the International Association of Industrial Accident Boards.

Industrial Sanitation.—Sanitation in industry as in the community at large involves the supervision of water supply, food control, waste disposal, and general cleanliness to which are likely to be added problems of lighting, heating, and ventilation. Principles involved in these activities are discussed elsewhere.

Food.—The supervision of such restaurants as may be maintained in or near industries may logically be mentioned as a part of the sanitation of the industry but the food problem is more than this. Of course the sanitation of the restaurant, the physical examination of food handlers, clean, pasteurized milk, adequate dish washing facilities for complete sterilization and sanitary wash rooms and toilets for food handlers must be provided. But the food problem does not end here.

In the steel-ship industry the author found that among 60,000 men in about 40 shipyards from 66 per cent to 90 per cent brought their lunches. These lunches were eaten cold and in most cases were not balanced from the dietetic standpoint. Moreover many men who bought lunches at the cafeterias paid fifty cents for their lunch, selecting nothing but desserts and many of these were of the pie crust and whip cream variety with relatively little nourishment. In this industry it was possible to secure improvements by placing custards, bread puddings, blanc mange, and other nourishing foods on the list of desserts and by placing booths at various points about the shipyard from which hot coffee and hot stew were served in sanitary individual containers to supplement the cold lunches brought from home.

By enlisting the help of the community health organizations in the food program, it was possible to secure practical demonstrations of how to prepare suitable lunches with a saving in expense, and further suggestions were supplied through columns of the monthly paper issued by the industry. The results of the campaign were most gratifying and the incident illustrates how sanitary and medical supervision, health education and the cooperation of the shop committees, the management and the health interests of the community must often combine for a health improvement.

Medical Activities.—The medical organization of an industry is to maintain the health of the working force and its object is threefold; first, to care for the man who becomes sick or injured while at work; second, to detect and correct defects which are remedial; and third, to detect diseased conditions in new employees which would endanger their own lives or those of their fellow workmen, thus making it possible to temporarily exclude or restrict the employment of this type of worker. This very important function is mentioned last because many medical departments exist where there is not as yet either a physical examination upon employment or a periodical examination of the workers. The United States, our greatest employer, has recently examined what was at the time its most important group of workers (soldiers and sailors) and has attempted to remedy some of the physical defects found. These men were picked from the age groups in which they are supposedly most vigorous and even then from one third to one half of them were unfit for full military service.

The industry is in much the same position as the government. It not only owes to the individual compensation for accident or illness acquired as a result of his occupation, but it also owes to the individual a knowledge of his physical condition, and the applicant should be so placed in the industry

TABLE SHOWING CAUSES FOR DRAFT REJECTION

CAUSES	PER CENT ALL REJECTIONS
Total rejections, for all causes	100.00
Alcohol and drugs	.43
Bones and joints	12.35
Development defects (height, weight, chest measurements, muscles)	8.37
Digestive system	.53
Ears	4.38
Eyes	10.65
Flatfoot (pathological)	3.87
Genitourinary (venereal)	1.33
Genitourinary (non-venereal)	1.35
Heart and blood vessels	13.07
Hernia	6.04
Mental deficiency	5.24
Nervous and mental disorders	5.07
Respiratory (tuberculosis)	8.67
Respiratory (nontuberculosis)	1.67
Skin	2.68
Teeth	3.16
Thyroid	1.76
Tuberculosis (of parts other than respiratory)	.88
All other defects	3.06
Cause not given	5.44

as not to aggravate his physical condition. It owes to the workers already in the plant protection against the entrance of infectious disease.

A great service can be rendered in improving the health of the industrial class by offering free medical examination. The workman is warned of a defect while it is still remediable and the young man is impressed with the importance of health when he looks forward to a physical examination as part of the process of "getting a job!" It may seem to the private practitioner of medicine and dentistry that the individual should merely be apprised of his physical condition and that he should seek medical treatment outside the industry. This,

of course, is what happens in a great number of cases. The worker always possesses the right to choose his physician and mode of treatment and frequently prefers to go to his family physician or dentist. On the other hand, however, there is no reason why the industry should not, if it chooses, offer to the workman medical and dental care free or at slight cost. The industry can frequently afford to do so as there is less lost time for the industry and for the employee when treatment is given at the factory.

The employee is insured against industrial accidents and industrial diseases and there is no obligation upon the industry or the insuring company to treat anything more than accident cases. Even where there is not a well organized service department, however, it is usually the policy to treat employees for minor ills such as headache, toothache, stomach cramps and the like, for which it is known they would not be likely to consult a physician.

An example of the value of a medical department may be seen in the experience of an industrial establishment (*Modern Hospital,* July, 1919) which offered optional physical examinations under the supervision of the Life Extension Institute beginning in May, 1915. Seventy per cent of the workers were examined and examinations were repeated in the three succeeding years. Later it was made compulsory for new employees. Out of 599 examined, only 5 were found to be normal; 594 required advice regarding their living habits or physical condition; 377 were directed to a physician, and of these 317 were not aware of any impairment whatsoever. The employees who, by later investigations, were found to be carrying out instructions numbered 361; those carrying them out partially, 66; those making plans to do so, 12; those who had done nothing, 160. Hence 439 of the employees have, or will have been benefited. Poor eyesight, teeth, heart disease, and incipient tuberculosis are particularly mentioned.

If the industrial physician or dentist is efficient and understands his position and the relationships of his department to

the workmen in the plant, the medical department is an aid to the industry in many ways. The industrial dentist and physician may be nearly or completely engrossed in administering professional services which only slightly differ from those of private practise, although there are certain industrial diseases with which both must be familiar. However, to be successful each must carry, in addition to his professional knowledge, the ability to command the friendship and respect of the men who come to him for treatment and to impress upon his patients the value and propriety of the sort of work he is doing.

Industrial Dentistry.—It is not difficult to prove the need of dental care for the industrial worker. In examining large groups of industrial workers, it has been found that 90 per cent or more of such people have dental defects. Thousands of men were excluded from general military service because of dental defects, and it is no wonder that now—when an increasing number of bodily defects are found to be due primarily or in part to local infections about the teeth—the importance of expert dental services begins to receive general recognition.

The dental clinics which have been established in various industries are not uniform in their methods of administration. The dentist may be full time or part time. Some industrial clinics give only an examination and the dental work is done by an outside dentist. Some give examinations and clean the teeth and some not only give examinations but the additional services of cleaning, filling, extraction, bridge, crown and plate work. Some even go so far as to give free dental services to the children of employees. In other industries dental work is not free but at the employee's expense although it may be done in the company's time. In still other industries where physical examinations are given by physicians, an arrangement is made with an outside dentist or dispensary to do the dental work for the industry at a reduced cost.

Disease Prevention and Health Education.—Every member of the medical department should appreciate the value and saving of disease prevention. And this activity must have the hearty support of the men in the industry if it is to be successful. Just as 75 per cent of accident prevention depends upon the Safety Organization of the workers, so health is acquired, maintained or lost by the individual. Health is like salvation; no one can secure yours for you. Health education in industry should not be built from the top down but from the bottom up. The general manager cannot limit preventable disease but the willing cooperation of the workers can do it. The health expert in industry who can interest and organize the men and women of the factory for health betterment both in the shop and in the community will accomplish more than a reduction in the morbidity rate. For after all life is not a matter of the pay envelope and the more men and women of the industrial class are interested in the conditions of the home, the conditions of labor, the health and welfare of their families and their fellow men, the more efficient will be our industries, the more stable our population, and the more intelligent our government.

INDUSTRIAL DISEASES

Two well recognized enemies to health are (1) dust, and (2) poisonous substances. Dust may be either organic or inorganic. It may or may not carry organisms of infection. Rag dust is highly infective; coal dust is practically free from infection. The dust may be merely irritating like stone dust in which case the extent of its irritability depends upon its shape or roughness; or the dust may be injurious because of its poisonous nature as in the case of lead. Poisonous substances in industries may be either gases, dust or liquids.

Tuberculosis.—Although dusts are injurious and irritating to the skin, their chief danger is to the lungs. Those

dusts which are rough and cutting particularly facilitate infection by piercing the tissues which line the lungs. There are ample data to indicate that the presence of irritating dust greatly increases the amount of tuberculosis. Sommerfeld (Die Schwindsucht Der Arbeiter) found that the number of deaths in every thousand due to tuberculosis of the lungs among workers in dust-free occupations to be 381, while the number of deaths from the same cause among workers in dusty trades was 480.

The following data from a study by Dr. Frederick L. Hoffman shows the percentage of all deaths due to tuberculosis. It will be seen that this disease produces a larger percentage of all deaths in occupations where there are irritating dusts.

PROPORTIONATE MORTALITY FROM TUBERCULOSIS OF THE LUNGS 1907-1910 OF OCCUPIED MALES IN CERTAIN OCCUPATIONS BY SPECIFIED AGE PERIODS

ALL OCCUPIED MALES	15 TO 24 YEARS PER CENT	25 TO 55 YEARS PER CENT
Farmers	26.9	32.1
Tailors	52.0	47.5
Carpenters	32.0	38.4
Masons	31.1	39.0
Bakers	24.1	37.2
Iron and steel workers	27.9	29.7
Painters	34.7	39.2
Cigar Makers	54.8	45.0
Machinists	39.3	40.0
Textile workers	38.6	45.5
Bartenders	34.1	35.7
Plumbers	32.8	41.7
Glass Workers	38.5	48.1
Stone Workers	33.3	47.8
Clerks	42.4	44.8
Printers	48.4	48.6

Lead Poisoning.—Lead is a common cause of serious poisoning. It is not readily eliminated from the body and even

small amounts which are swallowed or absorbed through the respiratory tract or the skin soon accumulate in serious quantity. One of the early symptoms of lead poisoning which may be seen even before serious physical defects are noticed is the blue line on the gums. This is usually a double line: a line upon the teeth just below the gum which may be removed by washing and another line upon the gums themselves and consisting of lead sulphite which has been thrown down at this point. The susceptibility to lead poisoning varies and young adults are most susceptible, women being more susceptible than men.

Lead is poisonous in almost any form although the soluble salts like the carbonates are more dangerous than the insoluble salts like the sulphates. For this reason, lead carbonate is eliminated from industries wherever possible. The most common methods of poisoning by lead are by the inhaling of lead dust, or by swallowing lead which is carried to the mouth in various ways by the hands. Absorption of the soluble lead salts through the skin may take place but this type of poisoning is relatively unimportant.

Other symptoms of lead poisoning include restriction of the secretion of saliva, a sweetish taste in the mouth, weakness, weak pulse, constipation, high blood pressure and anemia. Later developments may include wrist drop and encephalitis, which appears as an acute insanity. Lead poisoning has a peculiar danger in affecting the germ cells to such an extent that stillbirths are very common in families where either the father or the mother has taken lead into the system.

Phosphorus Poisoning.—A serious disease resulting from phosphorus poisoning is known as "phossy jaw." There is an extremely painful inflammation of the jaw bone in the early stages which later becomes chronic and produces a localized degeneration of the bone. The phosphorus produces either a septic gingivitis by inflaming the gums or an active inflammation by acting through decayed teeth. In either case

there is soon pus formation in the swollen gum and the painful jaw bone. There are two kinds of phosphorus; the white or yellow which is highly poisonous and the red or amorphous which is practically nonpoisonous.

Phosphorus poisoning was most common in the match industry but the modified methods of making matches have fortunately nearly eliminated the disease. In place of the old-fashioned phosphorus match we have a match made with the nonpoisonous sesqui-sulphid of phosphorus. The "safety match" contains potassium chlorate or chromate with other oxygenous substances and is scratched on a special surface which contains antimony sulphid and red phosphorus. Phosphorus poisoning still occurs where certain special processes —like the manufacture of bone black, phosphates or rat poisons—are carried on.

Mercury Poisoning—The indications of mercurial poisoning are ulcerations of the gums, loosening of the teeth, pain and swelling in the salivary glands, headache, anemia, tremor of the muscles, depleted breath and dizziness. Frequently the molar teeth are lost and the other teeth are black and eroded from the acid solution.

Mercury is absorbed through the respiratory system, the skin or the digestive system. Edsall has cited cases in dentists who had the habit of working their amalgam in the palm of the hand and thus absorbed mercury through the skin. Poisonings most frequently occur from the amalgam used in separating gold and silver ore and from the mercuric nitrates used in the fur dressing industry.

Benzene Compounds.—Among the other substances which produce mouth lesions may be included benzene which sometimes produces a chronic poisoning with purpuric hemorrhage of the mucous membranes of the mouth and throat. Aniline and nitro-benzene both produce a definite cyanosis of the lips and face usually spoken of as the "blues." These and other benzene compounds produce serious effects upon the nervous system.

Other Industrial Poisons.—Many other poisonous substances are used or formed in industrial processes. Each type of poisoning produces its peculiar group of effects upon the body. These substances include antimony, arsenic, carbon bisulphide, carbon monoxide, chromium, radium, strong acids, methyl alcohol and nitroglycerin. The rapid development of new chemical processes and new uses for various chemical substances make it necessary for industrial physicians to be always on the alert for new types of poisoning.

Protection Against Industrial Poison.—There are many measures of precaution which need to be taken to protect the the industrial worker. These include proper instruction concerning the nature of the industrial hazards, the installation of suitable ventilation to remove dust and fumes, the installation of wet processes for dry and dusty ones where possible, the use of proper protective clothing, and the liberal use of washing facilities which should be adequate for the working force. For a consideration of these matters, the reader must consult a more extensive work on the subject of Industrial Hygiene.

CHAPTER XVIII

VENTILATION, HEATING AND LIGHTING

The ventilation, heating and lighting of a man's place of work and his home directly affect his health and the health and comfort of his family. The professional man often fails to realize that the poor ventilation and lighting of his office increases both the discomfort and the irritability of his patients or clients. Everyone at some time or other has felt the oppressiveness of the air upon entering a poorly ventilated room. We are sensitive to certain changes of temperatures and barometric conditions. We appreciate the unusual fatiguing effect of a day's work in an office when the ventilation is poor, and we have high regard for the stimulating effect of outdoor life at the seaside or in the mountains during the summer. Everybody knows that there is a difference between good air and bad, but too few people know in what that difference consists and still fewer people have the energy and courage to insist upon suitable ventilation in office, home or public buildings.

GOOD AIR DEFINED

The old idea that the quality of air is determined by its chemical characteristics has been found to be wrong. As children most of us were taught that bad air was air poor in oxygen and loaded with carbon dioxide. It was thought that poor air must contain too little oxygen to supply the demands of the body, and that carbon dioxide acted as a body poison. Recent physiological experiments have shown that, contrary to the former belief, it is the physical and not the chemical character of the air which determines its quality. A comparison of the oxygen and carbon dioxide contents of outdoor air, exhaled air, and the air of poorly ventilated rooms shows the reasonableness of the discovery.

OXYGEN AND CARBON DIOXIDE CONTENT OF DIFFERENT KINDS OF AIR.

	Oxygen	Carbon dioxide
Composition of pure air	21%	.04%
Air in the lungs	16%	5.00%
The air in the worst ventilated rooms	19%	.40%
Composition of air which chemically produces physiological injury	14%	3.00%

It is to be noted that there is a wide difference between "close air" and air which produces injury by virtue of its chemical composition. Even in the worst ventilated room the air is chemically much better than that in the lungs.

Until very recently little attention was paid to the effect of air upon the skin, although now we recognize it as most important. It is hard to believe that the soft free air can make us uncomfortable by its contact with a thick tough structure like the skin until we realize that our skin not only receives the external contact stimuli but also helps to regulate the body temperature as it is acted upon by the air from without and the nervous system from within.

It is easy to forget that the skin is a sense organ, for unless we are either chilled or perspiring other more important thoughts and stimuli crowd these minor sensations into oblivion. It is like the ticking of a clock to which we have become accustomed. We work in the room and are not conscious that the clock is present and yet if it stops we are immediately aware of it.

The movement of air against the body produces definite sensations as it is easy to demonstrate. Step from the breezy porch of your summer cottage into a room with the doors and windows closed so that there is no movement of the air. Sit for a few minutes quietly and then return to the porch and see if the breezes do not have a pleasing and stimulating effect. The deadening effect inside the room was due to the fact that the air immediately about the body, *the aerial blanket,* was not being rapidly changed. There was very slight movement of air in the room and the clothes held this

"blanket" closely wrapped around the body. If we go out from a warm room in winter weather we notice a definite and marked reaction of the skin. Similar but lesser reactions are continually taking place in adjusting the body to the changing condition of air and no doubt the body receives an important stimulation from this gentle playing upon the nervous system by the changing air.

These considerations are in harmony with the results of experiments conducted by the New York Ventilating Commission and by other investigators. For example, a man is put in a closed box where the air is hot and moist. A feeling of discomfort soon develops which cannot be relieved by feeding the man air from the outside by means of a tube passed through the wall of the box. The symptoms of discomfort *are* relieved by turning on an electric fan inside the box, even when the subject breathes the air from within which has been vitiated by continuous breathing. On the other hand, a man sitting outside the box in air of proper temperature and humidity is not injuriously affected by breathing through a tube which supplies him with air from within even though it is vitiated, hot and moist. The effect is on the skin not on the lungs.

Experiments have failed to demonstrate the presence of any injurious organic substance or "crowd poison" in breathed air although it has been found that disagreeable odors produce a depressing effect upon the appetite.

We deduce from the foregoing statement that the most important problem in ventilation is a suitable change of the aerial blanket, and that moving air of the proper temperature and humidity, the wearing of clothes which allow reasonable ventilation to the skin, and the use of water and air baths to keep the skin clean, are the primary considerations.

Temperature.—The living body is continually producing heat. There is a continual loss of heat by radiation and conduction and when one is too warm there is loss of heat by evaporation of moisture from the surface of the body.

At a room temperature of approximately 68° F. the loss of heat by an inactive person balances the normal production of heat without much tax upon the heat-regulating mechanism. Should the temperature of the room go up above this point, the body must lose heat extensively by the evaporation of perspiration if the balance between heat production and heat loss is to be maintained. If the temperature goes below 60° such a chilliness is felt that the person begins to move about, if he is free to do so, thereby increasing the amount of heat produced through the increased oxidation resulting from muscular exercise. If the individual is not free to move about, he shivers. This is merely nature's way of increasing muscular activity. At low temperatures the muscles of the skin contract and the heat loss from the surface of the body is reduced to a minimum. But even so, we must give the body further protection by wearing heavier clothing. The best room temperature is 65° to 68°.

Moisture.—What effect does the varying moisture content of the air have upon the body? We know that water is a good conductor of heat and therefore if the air is moist and cold it will seem very chilly because the heat is conducted away from the body rapidly, even though the skin has reacted to the low temperature and reduced the evaporation of moisture. On the other hand, if the day is very hot and the air is moist the evaporation of perspiration will be less rapid because the air is already loaded with moisture. This prevents the body from cooling itself by the process of evaporation. It thus appears that a moist air seems colder at 35° and warmer at 95° than dry air at the same temperatures. In either case an increase in the *movement* of the air would make it seem colder or cooler because moving air continually changes the aerial blanket and increases heat transfer and evaporation.

Odors.—We have said that disagreeable odors are injurious to health in having a definite effect upon the appetite. They probably also irritate or depress the nervous system. To be sure the olfactory nerve soon becomes tired and insensible to a given odor but the depressing effect no doubt continues.

The nose can always detect a new odor or a different odor and for this reason the odor of the air is a good index of its freshness or staleness when one *first enters* the room. Odors arise from foul breath, an unclean mouth, decayed teeth, catarrh, the sudoriferous glands from the feet and axillæ, and

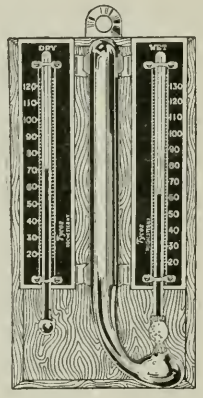

Fig. 59.—Wet and dry bulb thermometer for wall attachment. (Courtesy of the Taylor Instrument Companies, Rochester, N. Y.)

from the decomposition of organic matter on the skin and clothes. Moisture is always necessary for the detection of odors and they therefore become more objectionable as the air becomes more humid. Sometimes heat or a draft of compressed air will remove odors from solid surfaces where mere ventilation will not.

Testing Air.—The air in living rooms which is not being changed with sufficient frequency is likely to be odorous and it is not difficult to detect this with the senses upon entering a close or stuffy room. The test for the amount of carbon

dioxide in the air will also indicate whether the air is fresh or used. The temperature may be read directly from a thermometer.

But we must know the relative humidity of air as well as its temperature in order to know whether it is properly conditioned for the body. *Relative humidity* is expressed in terms of per cent saturation. When the air is completely saturated with moisture we have a mist or fog. At 68° F. the optimum humidity is about 50 per cent.

The body is sensitive to the dryness of the air because the drier the air the greater the evaporation of moisture. It is

Fig. 60.—Sling psychrometer. (Courtesy of the Taylor Instrument Companies, Rochester, N. Y.)

this principle that is used in determining relative humidity. If the bulb of an ordinary thermometer is wrapped in a moist cloth, evaporation will take place from the cloth and the thermometer will be cooled, registering a lower temperature than the ordinary thermometer in the same room. The drier the air, the greater the rate of evaporation, the greater will be the difference between the dry bulb and wet bulb readings. The movement of air also affects the rate of evaporation; but evaporation approaches its maximum rate when the air is moving at about four miles per hour, so that if the wet bulb

thermometer is swung in the air with a free arm motion the minimum reading can be obtained in a few moments.

The Sling Psychrometer.—An instrument in common use for testing the dryness of air is the sling psychrometer which consists of a dry bulb thermometer and a wet bulb thermometer attached to a solid frame which can be rotated in the air. The instrument is swung until the minimum reading is obtained on the wet bulb thermometer and the relative humidity is obtained by comparing the difference in temperatures with a set of standard tables. From these tables it is possible to

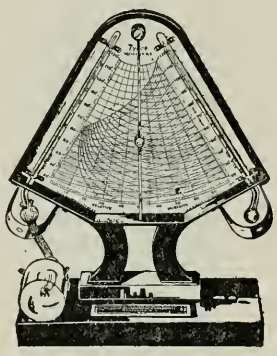

Fig. 61.—Hygrodeik showing the chart from which the condition of the air may be read directly. This is the most satisfactory instrument for telling moisture content quickly. (Courtesy of the Taylor Instrument Companies, Rochester, N. Y.)

obtain the relative humidity, the number of grams of moisture in the air and the dew point for the air having its dry and wet bulb temperatures recorded.

The Hygrodeik.—This instrument has a dry and a wet bulb thermometer placed on the two sides of a graphic chart in such a way that the approximate percentage saturation, grains of water per cubic foot, and dew point may be read directly from the chart by comparing the temperatures of the two thermometers. A pointer swings across the chart between the thermometers and the desired readings may be ob-

tained by placing it over the intersection of the two lines which connect the thermometer readings.

The Polymeter.—Various instruments are made which indicate roughly the relative humidity by showing the effect of moisture in contracting or expanding some substance like horse hairs. The horse hair is usually run from the top of the instrument to a shaft connecting with a dial at the base. If these instruments are kept in proper condition the dial will roughly indicate the amount of moisture in the air, that is, with an accuracy of perhaps 1° to 5°. But in order that they remain in good condition they should be dipped in water every day or at least every few days.

The Comfort Meter.—Dr. Hill has developed a new instrument for indicating the quality of the air which does away with the difficulty of trying to combine the two factors of temperature and humidity. This is a spirit thermometer graduated from 95° to 100° F. It is heated to 100° and the time taken to fall to 95° is registered. Without moisture this thermometer records the effect of the temperature and motion of the air; when a cloth saturated with water is wrapped around the bulb it also takes account of the effect of humidity. It will be seen that this instrument when moistened at 100° F. closely simulates the body, and the cooling effect of the air upon a moist warm body at any temperature can thus be readily determined. The instrument is calibrated and the constant factor is written upon the back. By dividing the time in seconds by the constant factor, one obtains the loss of heat per square centimeter per second in terms of milli-calories. The wet bulb should show not less than 18 milli-calories per second and the dry bulb not less than 6.

VENTILATING AND HEATING

The problem of ventilation is to supply clean air, free from bacteria and dust, at the proper temperature and with the suitable amount of moisture. To ventilate we must renew

the air in a room but in order to secure air which is properly conditioned we must often heat or cool, and moisten or dry the air in addition.

Merely because we have assigned new causes for the disagreeable effects which have always been recognized as the result of poor air, we must not forget that these ill effects still persist. Properly conditioned air must always be supplied and in a suitable quantity and standards of air space in different kinds of workrooms are still useful, although we should remember that the rate of change of air is more important than the size of the workroom.

Definite standards set by a committee of the American Society of Heating and Ventilation prescribe for a theatre, a floor space per person of 6 square feet, a cubic space of 90 cubic feet, and an air supply of 1,200 cubic feet per hour. In a workshop the floor space should be increased usually to 25 square feet, the cubic space to 250 cubic feet, and the hourly air supply to 1,500 cubic feet per person (the amount of air required for an ordinary gas burner). The air should be of a temperature between 60° and 72° F. The distribution should maintain the proper temperature without uncomfortable drafts or any draft lower than 60° F. For temperatures above 55° F. the most comfortable percentage humidity may be obtained from the formula $R = 316 - 4T$, where $T =$ the temperature of the room and $R =$ the corresponding relative humidity.

The air should be free from unpleasant odors and reasonably free from dust which of itself is more or less irritating and is usually germ laden. Mechanical exhaust systems are needed in many workrooms to keep the air free from dust, while air washing is necessary in some localities to secure a satisfactory supply.

Natural Ventilation.—Ventilation may be either natural or artificial. By natural ventilation we mean the replacing of air inside a building by the outside air which works its way of its own accord through the wall and through openings to

the outside. Even solid walls allow for the passage of a good deal of air and much more enters through open windows, ventilating flues, or chimneys, cracks or crevices in the walls, under doors and around windows. There are numerous mechanical appliances which furnish openings through walls or windows and assist in the interchanging of inside and outside air. Sometimes this exchange of air is assisted by aspirating or withdrawing the air from within by means of the natural draft of a flue or chimney augmented by a heater. The amount of leakage of air in a building depends on the ratio of the cubic contents of the building to the exposed surface, the tightness of doors, windows, etc., and the condition of the walls. In general it is assumed that the leakage amounts to one change of air per hour. That is, an amount of air equal to the cubical contents of a frame building will pass through the walls each hour and an equal volume of air must be heated to replace the loss. The air will oftentimes be changed two times per hour by spontaneous ventilation.

The size of the room as well as the number of people in the room influences the rate at which the air should be changed. The number of changes of air which take place under direct heating in buildings is given below.

NUMBER OF TIMES AIR CHANGES PER HOUR

Residences	Halls 3; sitting-rooms 2
Stores	First story 2 to 3; 2nd story 1½ to 2
Offices	First story 2 to 2½; 2nd story 1½ to 2
Churches and Halls	¾ to 2
Large rooms with small exposure	½ to 1

Artificial or Mechanical Ventilation.—For large buildings such as halls, churches, business establishments and factories, the change of air through natural processes is not sufficient and some mechanical system of ventilation is adopted. This may be one of three types: (1) the exhaust or *vacuum system* by which air is withdrawn from the room by means of suction fans, (2) the *plenum system* by which air is forced

into the room by fans or (3) the *combined method* which forcibly brings air into the room and forcibly exhausts it, combining both of the above systems.

There are various ways of introducing and removing air from a room, but in general it may be said that in buildings of moderate size such as residences, office-buildings, schoolrooms and factories, where the building is cut up into rooms not over fifty feet square, the intake ducts should be in the side walls near the top of the room from eight to ten feet above the floor and should discharge the air with a velocity not exceeding 6 feet per second so that the drafts will not be felt. Exit ducts should be in the side walls near the floor. By bringing the heated air in at the top of the room its velocity is gradually dissipated and by the time the incoming air has descended to the breathing level no draft should be felt. The opening of a register should be from 0.66 to 0.75 of the area of the opening in the duct into which the register fits.

In modern factories the air is heated to a temperature of from 90°-140° and is forced into the building by fans. This air after supplying wall losses by its loss in temperature is taken back to the fan at 60°-70° and is then drawn through the heater, heated again to the higher temperature and forced back into the factory. The air in the factory is thus put under a slight pressure and any leakage of air is outward, therefore a small amount of outside air must be constantly added before the air passes through the heater.

There are various ways of distributing the air sent in by the fans. The most common method is by ducts located from 8 to 18 feet above the floor. It is also done by means of hollow pilasters in the sides of the long distributing ducts which extend the entire length of the building. The velocity of the discharged air varies from 3 to 50 feet per second depending on the size of the room. Where there are numerous outlets and low velocities, the combined area of the air inlets should exceed the discharge area of the fan by 25 per cent.

The Importance of Moisture.—It may be demonstrated that the air in a room at 65° F. and 50-55% relative humidity, actually feels warmer than that of a room which is maintained at 70-75° F. and 30% relative humidity. This is due to the fact that the sensation of heat or cold felt by the body, or the "sensible temperature" is not indicated by the temperature of the dry bulb thermometer, but more closely corresponds to the temperature indicated by the wet bulb thermometer. From this it is evident that a higher temperature is maintained in our buildings than would be required if arrangements were made for maintaining the proper relative humidity.

If a room feels cold at 68° F. it is because the humidity is too low. The amount of moisture a cubic foot of air will hold depends entirely upon the temperature. The lower the temperature of the air, the less moisture it is capable of holding. Air at 70° F. will, if saturated, hold 8 grains of moisture per cubic foot. Air at 0° F. will hold practically 0.48 grains per cubic foot at saturation. The average relative humidity during winter is about 70%; hence air at 0° F. and 70% relative humidity contains 0.34 grains of moisture per cubic foot. If this air is drawn from outdoors into a building and heated to 70° F. the absolute humidity or the weight of moisture per cubic foot will remain the same as before, but the relative humidity is now reduced to about 4%. Such air is drier than that of the most arid region.

Dry furnace air is therefore likely to cause excessive evaporation and give one a chilly feeling. For living rooms and offices the humidity may be increased by plants, or by porous dishes, like flower-pots, containing water or by placing a dish of water or a wet towel on or near the radiator. It is evident that fuel can be saved by maintaining air of a reasonably high humidity.

A wet bulb temperature of 56° F. is a better standard for proper air condition than a dry bulb temperature of 65° to 68°.

Air Washing and Humidifying.—Although the humidity may be secured by simple devices in small rooms, more intensive methods must be used for large buildings. The types of air-washers and humidifiers in ordinary use are the "moist sheet"; "film of water"; and the "spray or rain" types. These are all modifications of one another and in all the water is forced through small openings in pipes so that a sheet of water is formed, through which the air must pass. The water is discharged through perforated pipes extending across the top of chambers, these pipes discharging against a deflector.

In the general method of washing and conditioning air it is first drawn through the washer by means of a fan. The water carried mechanically by the air is separated by means of eliminator plates; then the saturated air is heated by heater-coils to the desired temperature. By regulating the temperature of the saturated air entering the heater, the humidity of the heated air may be made any desired amount. By the use of by-passes under the heating coils, mixing dampers, thermostats, etc., it is possible to supply a constant volume of pure air to the rooms and to regulate the humidity of this air. Tempering coils are important where the incoming air is apt to go below 32° F., especially where all the air handled is taken from out of doors.

The washing of air is often almost as important as the humidifying. It is necessary to use the outside air for ventilation and this air is taken from the lower levels where the amounts of dust, bacteria, and noxious gases are most concentrated. Whipple has shown that when street air is passed through a washer it requires but a few hours for the water to become like sewage in appearance and analysis. Air drawn from the rooms, purified and reheated is up to all standards and the cost of fuel necessary to heat the air is considerably reduced.

Cooling Air.—To cool air and at the same time to reduce the amount of moisture, it becomes necessary to work with water at a temperature lower than can ordinarily be obtained from either driven wells or from city mains. Air cooled by ice is unsatisfactory as it is difficult to cool it sufficiently to deposit the excess moisture and the slightly cooled air is likely to have a high relative humidity.

The only satisfactory method of air cooling is by the use of refrigerating machines, such as ammonia compression or absorption machines by which the temperature may be reduced enough to cause a precipitation of the excess of moisture contained in the air. When air is cooled by this method a fan draws the air from the room and sends it through a sheet of cold brine which is continually cooled by an ammonia outfit. This brine is sprayed into the air as is the water in an air washing machine.

In other cases the air may be sent through a cooler containing the coils of an ammonia machine. To keep the coils from becoming covered with frost, brine is allowed to trickle over them. This brine washes the air to some extent. It is very important that the brine be of sufficient strength to prevent freezing.

Air taken in from the room may be cooled, de-humidified and sent back or some of the outside air of higher temperature and humidity may be mixed with cooled air in proper proportion to give the final temperature and humidity desired. In general it is necessary to cool air to 45° or 50° in order to get rid of the excess moisture, and it is then necessary to heat this air again to 70°. The hot moist air on its way from the room to the cooler may be made to transfer some of its heat to the cold, de-humidified air on its way back to the room.

The Economic Value of Good Ventilation.—Industries have found that it is particularly important to remove dust, gases and fumes which irritate the breathing passages of the worker and cause congestion or predispose the individual to infectious diseases. But even where dusts are not present the proper

regulation of temperature and humidity has an important bearing upon health and efficiency. Dr. Winslow has shown that under the same conditions of work 6 per cent more typewriting is performed at 68° than at 75°. In more vigorous physical work such as ordinary industrial activities, the amount accomplished at 68° is 15% greater than that accomplished at 75°.

Physicians feel that out of door air is better than inside air for invalids and consumptives, even though the inside air is properly conditioned. This benefit from being out of doors may be due to sunlight or it may be due to the constantly varying temperature of the outdoor air which doubtless serves as a stimulus and tonic to the system.

LIGHTING

Good lighting is important in a variety of ways. Direct sunlight is a disinfectant and it has been found to increase the peripheral lymphocytosis in the body. Its value in treating tuberculosis of the skin, for example, has been well demonstrated. It should be allowed to enter the home and the work place as much as possible but it should be prevented from shining directly in the face of the worker.

Outdoor life is the normal condition to which man has become accustomed throughout the process of evolution. Under these conditions the light comes from a luminous body above and very little light is reflected from the green or brown of the earth, so that the upper part of the retina is not accustomed to a strong stimulation. If the person looks up at the sun directly the stimulation is excessive and painful. This suggests the ideal condition for artificial lighting. Strong light should not be thrown directly into the eyes from below.

Man has acquired great power in adjusting the eyes to the effects of bright daylight and darkness. This is done by varying the size of the pupil through the muscular contraction of the iris. Flickering light causes the eye to attempt a

rapid series of these adjustments, a continual contraction and expansion of this muscle resulting in eye strain, nervousness and fatigue.

Ideal lighting provides sufficient and steady illumination at the point of work and the lighting should be judged not by

Fig. 62.—A foot candlemeter which is portable and easy to use in measuring light intensities. (Courtesy of the National Lamp Works, Cleveland, Ohio.)

the brightness of the lamps but by the illumination at the point where the work is done. Dark objects require more illumination than light objects.

APPENDIX A

THE CONTROL OF COMMUNICABLE DISEASES

For the convenience of the teacher who may wish to consider the communicable diseases in more detail, and for the convenient reference of the student, we have added this appendix which presents the important public health facts regarding the more common diseases of this group. These facts are presented in the form of a Committee report used here with the permission of the American Public Health Association. It has been thought useful to precede the Committee report with a set of brief definitions to indicate to the student the nature of those diseases with which he is not already familiar.

Definitions

Actinomycosis (Lumpy Jaw),—a disease of cattle causing suppurating tumors, especially about the jaw. It is transmissible to man.

Acute Infectious Conjunctivitis,—an acute inflammation of the conjunctiva differing somewhat in nature according to the causative organism.

Ankylostomiasis (Hookworm),—an intestinal infection sometimes with few symptoms, but commonly with signs of anemia, malnutrition and mental retardation.

Anthrax is a disease of cattle and sheep which may be transmitted to men. External anthrax is of two types. Malignant pustule assumes the form of a rapidly growing furuncle. Malignant edema is a disease which spreads rapidly through the subcutaneous tissues. Internal anthrax is an acute inflammatory process which may take place either in the lungs or in the intestines.

Cerebrospinal Meningitis (epidemic),—an inflammation of the membranes which envelope the brain and spinal cord.

Chickenpox,—an acute eruptive disease with mild constitutional disorders.

Cholera,—an acute intestinal infection characterized by diarrhea, rice-water evacuations, vomiting and cramps.

Dengue (Break Bone Fever),—a tropical or sub-tropical fever developing with sudden rise of temperature, pains in the head, joints and muscles.

Diphtheria,—an inflammatory infection of the throat and nose from which toxin is absorbed into the system.

Dysentery,—an intestinal infection accompanied by fever, gripping pains, and persistent diarrhea.

Epidemic (Lethargic) Encephalitis,—infectious disease of unknown origin, characterized by progressive stupor and irregular fever.

Favus,—a skin disease characterized by dry, sulphur yellow crust about the hairs of the scalp.

German Measles,—a febrile disease resembling measles in many respects.

Glanders,—a disease of the horse producing nodules in the nostrils (glanders) or beneath the skin (farcy). It is communicable to man.

Gonorrhea,—an inflammation of the lining of the urogenital tract.

Influenza,—a respiratory disease accompanied with fever and acute prostration.

Impetigo,—an inflammatory skin disease.

Leprosy,—an infectious disease characterized by nodules, ulcerations and disturbances of sensation.

Malaria,—a blood infection with characteristic chills and fever.

Malta Fever,—characterized by profuse perspiration, constipation, rheumatic or neuralgic pains.

Measles,—a usually mild, febrile disease with catarrhal symptoms followed by a characteristic eruption.

Meningococcus Meningitis,—a disease of the meninges of the brain and cord.

Mumps,—a nonsuppurative inflammation of the parotid and other salivary glands.

Paratyphoid Fever,—an intestinal infection with fever similar to typhoid fever in many respects.

Plague,—there are three forms of plague: the bubonic type is an infection of the lymphatic glands with fever and chills, the pneumonic type an infection of the lungs, and the septicemic type an infection of the blood.

Pneumonia,—an acute inflammatory process of the lungs.

Poliomyelitis,—an infectious disease with lesions in the central nervous system frequently producing motor paralyses.

Rabies,—an infectious disease of animals transmissable to man, characterized by convulsions followed by paralyses.

Rocky Mountain Spotted Fever,—a slowly developing fever with skin eruptions.

Scabies (Itch),—an itching contagious eruption of the skin caused by the itch mite.

Scarlet Fever,—a rapidly developing fever with inflammation of the upper respiratory tract together with a scarlet rash followed by desquamation.

Septic Sore Throat,—an infectious inflammation of the throat.

Smallpox,—a febrile disease with characteristic pustular eruption.

Syphilis,—a specific disease sometimes beginning with a local sore and later developing lesions in the nervous system and other parts of the body.

Tetanus,—an infection, usually from a wound, accompanied by toxemia and spasms of the voluntary muscles especially those of the lower jaw.

Trachoma,—an infectious process in the eye which impairs vision by progressive changes in the conjunctiva and subconjunctival tissue.

Trichinosis,—a fever beginning with diarrhea and followed by violent muscular pains.

Tuberculosis,—an infection most commonly in the lungs, but sometimes in other parts of the body, producing destruction of normal tissue with the formation of tubercles and subsequent symptoms according to the location of the disease.

Tularemia,—an infection transmitted from rabbits and other small animals, marked by swollen glands and fever.

Typhoid Fever,—an infectious febrile disease arising from a specific intestinal infection.

Typhus Fever (Jail fever, Spotted fever),—an intestinal and eruptive fever.

Whooping Cough,—an inflammation of the respiratory tract accompanied by a characteristic cough.

Yellow Fever,—a severe fever usually characterized by bloody vomit, diarrhea, jaundice and profound prostration.

THE CONTROL OF COMMUNICABLE DISEASES

Report of the Committee on Standard Regulations for the Control of Communicable Diseases

Foreword*

Standard regulations for the control of communicable diseases were recommended by a committee of the American Public Health Association, in October, 1916. This report was published by the United States Public Health Service in *Public Health Reports* for October 12, 1917. Reprints of this report were the standard guide in communicable disease practice for many years. Our knowledge of the nature of these diseases grew, however, and in 1925 a new committee was appointed by the Association to draft a revised report which would take into account our newer knowledge. This revised report, which closely follows the style of the earlier report, has been officially approved by the United States Public Health Service and was published by it in the *Public Health Reports* for December 17, 1926. It is here republished with certain corrections.

This revised report of the Committee for the Control of Communicable Diseases was presented before the Public Health Administration Section at the Fifty-fifth Annual Meeting of the American Public Health

*Report of the American Public Health Association Committee on Standard Regulations, Appointed in October, 1925.

Association at Buffalo, N. Y., on October 11, 1926. Publication of the revised report was approved by the Governing Council of the Association on October 14, 1926.

The committee acknowledges gratefully the collaboration of the following sanitarians who generously contributed to the present revised text: Doctors Charles V. Chapin, Edwin O. Jordan, William H. Park, J. F. Anderson, E. C. Levy, E. S. Godfrey, and certain medical officers of the Public Health Service.

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List of Diseases

Actinomycosis
Acute infectious conjunctivitis
Ancylostomiasis (hookworm)
Anthrax
Chicken pox
Cholera
Dengue
Diphtheria
Dysentery (amoebic)
Dysentery (bacillary)
Epidemic (lethargic) encephalitis
Favus
German measles
Glanders
Gonorrhea
Influenza
Leprosy
Malaria
Malta fever
Measles
Meningococcus meningitis
Mumps
Paratyphoid fever
Plague
Pneumonia (acute lobar)
Poliomyelitis
Rabies
Rocky Mountain spotted or tick fever
Scarlet fever
Septic sore throat
Smallpox
Syphilis
Tetanus
Trachoma
Trichinosis
Tuberculosis (pulmonary)
Tuberculosis (other than pulmonary)
Tularæmia
Typhoid fever
Typhus fever
Whooping cough
Yellow fever

Definitions of Terms

The committee adopted the following definitions of terms:

1. Carrier. A person who, without symptoms of a communicable disease, harbors and disseminates the specific microörganisms.

2. Cleaning. This term signifies the removal by scrubbing and washing, as with hot water, soap, and washing soda, of organic matter

on which and in which bacteria may find favorable conditions for prolonging life and virulence; also the removal by the same means of bacteria adherent to surfaces.

3. CONTACT. A "contact" is any person or animal known to have been sufficiently near to an infected person or animal to have been presumably exposed to transfer of infectious material directly, or by articles freshly soiled with such material.

4. DELOUSING. By delousing is meant the process by which a person and his personal apparel are treated so that neither the adults nor the eggs of Pediculus corporis or Pediculus capitis survive.

5. DISINFECTION. By this is meant the destroying of the vitality of pathogenic microörganisms by chemical or physical means.

When the word *concurrent* is used as qualifying disinfection, it indicates the application of disinfection immediately after the discharge of infectious material from the body of an infected person, or after the soiling of articles with such infectious discharges, all personal contacts with such discharges or articles being prevented prior to their disinfection.

When the word *terminal* is used as qualifying disinfection, it indicates the process of rendering the personal clothing and immediate physical environment of the patient free from the possibility of conveying the infection to others, at the time when the patient is no longer a source of infection.

6. DISINFESTING. By disinfesting is meant any process, such as the use of dry or moist heat, gaseous agents, poisoned food, trapping, etc., by which insects and animals known to be capable of conveying or transmitting infection may be destroyed.

7. EDUCATION IN PERSONAL CLEANLINESS. This phrase is intended to include all the various means available to impress upon all members of the community, young and old, and especially when communicable disease is prevalent or during epidemics by spoken or printed word, and by illustration and suggestion, the necessity of:

(1) Keeping the body clean by sufficiently frequent soap and water baths.

(2) Washing hands in soap and water after voiding bowels or bladder and always before eating.

(3) Keeping hands and unclean articles, or articles which have been used for toilet purposes by others, away from mouth, nose, eyes, ears, and vagina.

(4) Avoiding the use of common or unclean eating, drinking, or toilet articles of any kind, such as towels, handkerchiefs, hair brushes, drinking cups, pipes, etc.

(5) Avoiding close exposure of persons to spray from the nose and mouth, as in coughing, sneezing, laughing, or talking.

8. FUMIGATION. By fumigation is meant a process by which the

destruction of insects, as mosquitoes and body lice, and animals, as rats, is accomplished by the employment of gaseous agents.

9. Isolation.[1] By isolation is meant the separating of persons suffering from a communicable disease, or carriers of the infecting organism, from other persons, in such places and under such conditions as will prevent the direct or indirect conveyance of the infectious agent to susceptible persons.

10. Quarantine.[1] By quarantine is meant the limitation of freedom of movement of persons or animals who have been exposed to communicable disease for a period of time equal to the longest usual incubation period of the disease to which they have been exposed.

11. Renovation. By renovation is meant, in addition to cleansing, such treatment of the walls, floors, and ceilings of rooms or houses as may be necessary to place the premises in a satisfactory sanitary condition.

12. Report of a Disease. By report of a disease is meant the notification to the health authorities, and, in the case of communicable disease in animals, also to the respective departments of agriculture which have immediate jurisdiction, that a case of communicable disease exists in a specified person or animal at a given address.

13. Susceptibles. A susceptible is a person or animal who is not known to have become immune to the particular communicable disease in question by natural or artificial process.

The items considered necessary for presentation by the committee with regard to each disease are the following:

1. Infectious agent.
2. Source of infection.
3. Mode of transmission.
4. Incubation period.
5. Period of communicability.
6. Methods of control.

(A) The infected individual and his environment—

1. Recognition of the disease.
2. Isolation.
3. Immunization.
4. Quarantine.
5. Concurrent disinfection.
6. Terminal disinfection.

(B) General measures.

(C) Epidemic measures (occasionally require separate mention).

[1] In view of the various ambiguous and inaccurate uses to which the words isolation and quarantine are not infrequently put, it has seemed best to adopt arbitrarily the word isolation as describing the limitation put upon the movements of the known sick or "carrier" individual or animal, and the word quarantine as describing the limitations put upon exposed or "contact" individuals.

Important Measures in Boldface Type

Certain measures in the control of some diseases are of particular importance, on account either of their efficiency in preventing the disease or of the danger if they are neglected, and also on account of their proven practicability. These are emphasized in the text by being printed in **boldface type.**

Actinomycosis

1. Infectious Agent. *Actinomyces bovis.*
2. Source of Infection. The nasal and bowel discharges, and the infected material from lesions in human and animal cases of the disease. Uncooked meat from infected animals may serve as a source of infection.
3. Mode of Transmission. By contact with the discharges or with articles freshly soiled with the discharges from animal or human cases.
4. Incubation Period. Unknown.
5. Period of Communicability. As long as open lesions remain, as proved by the presence of the infectious agent on microscopic or cultural tests.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by microscopic examination of discharges from the lesions.
2. *Isolation*—None, provided the patient is under adequate medical supervision.
3. *Immunization*—None.
4. *Quarantine*—None.
5. *Concurrent disinfection*—Of discharges from lesions and articles soiled therewith.
6. *Terminal disinfection*—By thorough cleaning.

(B) General measures—

1. Inspection of meat, with condemnation of carcasses, or infected parts of carcasses, of infected animals.
2. Destruction of known animal sources of infection.

Acute Infectious Conjunctivitis
(Not Including Trachoma)

(This title to replace the terms gonorrheal ophthalmia, ophthalmia neonatorum, and babies' sore eyes.)

1. Infectious Agent. The gonococcus or some member of a group of pyogenic organisms, including the hemoglobinophilic bacilli.
2. Source of Infection. Discharges from comjunctivæ, or adnexa, or genital mucous membranes of infected persons.

3. Mode of Transmission. Contact with an infected person or with articles freshly soiled with discharges of such person.
4. Incubation Period. Irregular, but usually thirty-six to forty-eight hours.
5. Period of Communicability. During the course of the disease and until the discharges from the infected mucous membranes have ceased.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the diseases*—Clinical symptoms, confirmed where possible by bacteriological examination.

2. *Isolation*—None, provided the patient is under adequate medical supervision.

3. *Immunization*—None.

4. *Quarantine*—None.

5. *Concurrent disinfection*—Disinfection of conjunctival discharges and articles soiled therewith.

6. *Terminal disinfection*—Thorough cleansing.

(B) General measures—

1. Enforcement of regulations forbidding the use of common towels and toilet articles. Education as to personal cleanliness.

2. Use of silver nitrate or some similar solution in the eyes of the newborn.

3. Carrying out of the measures indicated in methods of control for gonorrhea.

Ancylostomiasis
(Hookworm)

1. Infectious Agent. Ancylostoma (*Necator americanus.*)
2. Source of Infection. Feces of infected persons. Infection generally takes place through the skin, occasionally by the mouth.
3. Mode of Transmission. The larval forms pierce the skin, usually of the foot, and passing through the lymphatics to the vena cava and the right heart, thence in the blood stream to the lungs, they pierce the capillary walls and pass into the alveoli. Then they pass up the bronchi and trachea to the throat, whence they are swallowed and finally lodge in the small intestine. Also by drinking water containing larvæ, by eating soiled food, by hand to mouth transmission of the eggs or larvæ from objects soiled with infected discharges. The chief reservoir of infectious materials is *contaminated soil.*

4. Incubation Period. Seven to ten weeks.
5. Period of Communicability. As long as the parasite or its ova are found in the bowel discharges of an infected individual. Contaminated soil remains infective for five months in the absence of freezing.
6. Methods of Control:
   (A) The infected individual and his environment—
      1. *Recognition of the disease*—Microscopic examination of bowel discharges.
      2. *Isolation*—None.
      3. *Immunization*—None.
      4. *Quarantine*—None.
      5. *Concurrent disinfection*—Sanitary disposal of bowel discharges to prevent contamination of soil and water.
      6. *Terminal disinfection*—None.
      7. *Treatment*—Appropriate treatment of infected individual to rid the intestinal canal of the parasite and its ova.
   (B) General measures—
      1. Education as to dangers of soil pollution.
      2. Prevention of soil pollution by installation of sanitary disposal systems for human discharges.
      3. Personal prophylaxis by cleanliness and the wearing of shoes.

Anthrax

1. Infectious Agent. Anthrax bacillus, *Bacillus anthracis.*
2. Source of Infection. Hair, hides, flesh, and feces of infected animals.
3. Mode of Transmission. Inoculation as by accidental wound or scratch, inhalation of spores of the infectious agent, and ingestion of insufficiently cooked infected meat.
4. Incubation Period. Within seven days.
5. Period of Communicability. During the febrile stage of the disease and until lesions have ceased discharging. Infected hair and hides of infected animals may communicate the disease for many months after slaughter of the animal, and after curing of hide, fur, or hair, unless disinfected.
6. Methods of Control:
   (A) The infected individual and his environment—
      1. *Recognition of the disease*—Clinical symptoms, confirmed by bacteriological examination.
      2. *Isolation* of the infected individual until the lesions have healed.

3. *Immunization*—None.

4. *Quarantine*—None.

5. *Concurrent disinfection* of the discharges from lesions and articles soiled therewith.

6. *Terminal disinfection*—Thorough cleaning.

(B) General measures—

1. Animals ill with a disease presumably anthrax should be placed immediately in the care of a veterinary surgeon. Proved animal cases of the disease should be killed promptly and the carcasses destroyed, preferably by fire.

2. Isolation of all animals affected with the disease.

3. Immunization of exposed animals under direction of Federal or State Department of Agriculture.

4. Postmortem examination should be made only by a veterinary surgeon, or in the presence of one.

5. Milk from an infected animal should not be used during the febrile period.

6. Control and disinfection of effluents and trade wastes and of areas of land polluted by such effluents and wastes from factories or premises, where spore-infected hides or other infected hide and hair products are known to have been worked up into manufactured articles.

7. A physician should be constantly employed by every company handling rawhides, or such companies should operate under the direct supervision of a medical representative of the health department.

8. Every employee handling rawhides, hair, or bristles who has an abrasion of the skin should immediately report to a physician.

9. Special instruction should be given to all employees handling rawhides in regard to the necessity of personal cleanliness.

10. Tanneries and woolen mills should be provided with proper ventilating apparatus so that dust can be promptly removed.

11. Disinfection of hair, wool, and bristles of animals originating in known infected centers before they are used or assorted.

12. The sale of hides from an animal infected with anthrax should be prohibited. A violation of this regulation should be immediately reported to the State commissioner of agriculture, by telegram, stating the time, place, and purchaser to whom

the hide was sold. The report should also be sent to the person purchasing the hide. Carcasses should be disposed of under the supervision of the State Department of Agriculture. The inspection and disinfection of imported hides are under the supervision of the United States Bureau of Animal Industry. In the event that infection is introduced the State agricultural authorities have jurisdiction over infected animals and the local or State health authorities have jurisdiction over infected persons.

Chicken Pox

1. Infectious Agent. Unknown.
2. Source of Infection. The infectious agent is presumably present in the lesions of the skin and of the mucous membranes; the latter appearing early and rupturing as soon as they appear, render the disease communicable early, that is, before the exanthem is in evidence.
3. Mode of Transmission. Directly from person to person; indirectly through articles freshly soiled by discharges from an infected individual.
4. Incubation Period. Two to three weeks.
5. Period of Communicability. Until the primary scabs have disappeared from the mucous membranes and the skin.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms. **The chief public health importance of this disease is that cases thought to be chicken pox in persons over 15 years of age, or at any age during an epidemic of smallpox, are to be investigated to eliminate the possibility of their being smallpox.**

2. *Isolation*—Exclusion of patient from school, and prevention of contact with nonimmune persons.

3. *Immunization*—None.

4. *Quarantine*—None.

5. *Concurrent disinfection* of articles soiled by discharges from lesions.

6. *Terminal disinfection*—Thorough cleaning.

(B) General measures—None.

Cholera

1. Infectious Agent. Cholera vibrio. *Vibrio comma.*
2. Source of Infection. Bowel discharges and vomitus of infected persons, and feces of convalescent or healthy carriers. Ten per cent of contacts may be found to be carriers.

3. Mode of Transmission. By food and water polluted by infectious agent; by contact with infected persons, carriers, or articles freshly soiled by their discharges; by flies.
4. Incubation Period. One to five, usually three days, occasionally longer if the healthy carrier stage before development of symptoms, is included.
5. Period of Communicability. Usually seven to fourteen days or longer and until the infectious organism is absent from the bowel discharges.

6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by bacteriological examination.

2. *Isolation* of patient in hospital or screened room.

3. *Immunization* by vaccination may be of value.

4. *Quarantine*—Contacts for five days from last exposure, or longer if stools are found to contain the cholera vibrio.

5. *Concurrent disinfection*—Prompt and thorough disinfection of the stools and vomited matter. Articles used by and in connection with the patient must be disinfected before removal from the room. Food left by the patient should be burned.

6. *Terminal disinfection*—Bodies of those dying from cholera should be cremated if practicable, or, otherwise, wrapped in a sheet wet with disinfectant solution and placed in water-tight caskets. The room in which a sick patient was isolated should be thoroughly cleaned and disinfected.

(B) General measures—

1. Rigid personal prophylaxis of attendants by scrupulous cleanliness, disinfection of hands each time after handling patient or touching articles contaminated by dejecta, the avoidance of eating or drinking anything in the room of the patient, and the prohibition of those attendant on the sick from entering the kitchen.

2. The bacteriological examination of the stools of all contacts to determine carriers. Isolation of carriers.

3. Water should be boiled, if used for drinking or toilet purposes, or if used in washing dishes or food containers, unless the water supply is adequately protected against contamination or is so treated, as by chlorination, that the cholera vibrio cannot survive in it.

4. Careful supervision of food and drink. Where cholera is prevalent, only cooked foods should be used. Food and

drink after cooking or boiling should be protected against contamination, as by flies and human handling.

(C) Epidemic measures—

Inspection service for early detection and isolation of cases; examination of persons exposed in infected centers for detection of carriers, with isolation or control of carriers; disinfection of rooms occupied by the sick, and the detention, in suitable camps for five days, of those desirous of leaving for another locality. Those so detained should be examined for detection of carriers.

Dengue

1. Infectious Agent. Unknown.
2. Source of Infection. The blood of infected persons.
3. Mode of Transmission. By the bite of infected mosquitoes, *Aedes aegypti.*
4. Incubation Period. Three to ten days.
5. Period of Communicability. From the day before onset to the fifth day of the disease.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms.
2. *Isolation*—The patient must be kept in a screened room.
3. *Immunization*—None.
4. *Quarantine*—None.
5. *Concurrent disinfection*—None.
6. *Terminal disinfection*—None. Upon termination of the case, fumigation of the room and house, to destroy mosquitoes.

(B) General measures—

Measures directed toward elimination of mosquitoes (Aedes aegypti). Screening of rooms.

Diphtheria

1. Infectious Agent. Diphtheria bacillus, *Corynebacterium diphtheriae,* the Klebs-Loeffler bacillus.
2. Source of Infection. Discharges from diphtheritic lesions of nose, throat, conjunctiva, vagina, and wound surfaces. Secretions from the nose and throat of carriers of the bacillus.
3. Mode of Transmission. Directly by personal contact, indirectly by articles freshly soiled with discharges, or through infected milk or milk products.

4. Incubation Period. Usually two to five days, occasionally longer if a healthy carrier stage precedes the development of clinical symptoms.

5. Period of Communicability. Until virulent bacilli have disappeared from the secretions and the lesions. The persistence of the bacilli after the lesions have healed is variable. In fully three-fourths of the cases they disappear within two weeks. In 95 per cent of cases, the bacilli disappear in four weeks. In exceptional cases virulent bacilli remain in the throat and discharges for from two to six months.

6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—By clinical symptoms with confirmation by bacteriological examination of discharges.

2. Isolation—Until two cultures from the throat and two from the nose, taken not less than twenty-four hours apart, fail to show the presence of diphtheria bacilli. Isolation may be terminated if persistent diphtheria bacilli prove avirulent. Where termination by culture is impracticable, cases may be terminated with fair safety as a rule sixteen days after onset of the disease.

3. *Immunization*—Exposed susceptibles who cannot be kept under daily observation by a physician or nurse should be promptly immunized by antitoxin. (By susceptibles is meant such individuals as are found to be nonimmune by the Schick test, i.e., those who give a positive reaction.)

4. *Quarantine*—All exposed persons until shown by bacteriological examination not to be carriers.

5. *Concurrent disinfection* of all articles which have been in contact with the patient and all articles soiled by discharges from the patient.

6. *Terminal disinfection*—At the end of the illness, thorough airing and sunning of the sick room, with cleaning or renovation.

(B) General measures—

1. Pasteurization of milk supply.

2. Application of the Schick test to all especially exposed persons, such as nurses and physicians, and active immunization of all susceptibles, but not within three weeks after the administration of antitoxin.

3. Active immunization of all children by the end of the first year without prior Schick testing; active immunization

of school children with or without prior use of the Schick test.

4. Determination of presence or absence of carriers among contacts and, so far as practicable, in the community at large.

Dysentery (Amœbic)

1. Infectious Agent. *Endamoeba histolytica.*
2. Source of Infection. The bowel discharges of infected persons.
3. Mode of Transmission. By drinking contaminated water, and by eating infected foods, and by hand-to-mouth transfer of infected material; from objects soiled with discharges of an infected individual, or of a carrier; by flies.
4. Incubation Period. Unknown.
5. Period of Communicability. During course of disease and until repeated microscopic examination of stools shows absence of Amœba histolytica.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by microscopic examination of stools.
2. *Isolation*—None.
3. *Immunization*—None.
4. *Quarantine*—None.
5. *Concurrent disinfection* of the bowel discharges.
6. *Terminal disinfection*—Cleaning.

(B) General measures—

1. Boil drinking water unless the supply is known to be free from contamination.
2. Water supply should be protected against contamination, and supervision should be exercised over all foods eaten raw.

Dysentery (Bacillary)

1. Infectious Agent. Dysentery bacillus, *Eberthella dysenteriae, Eberthella para dysenteriae.*
2. Source of Infection. The bowel discharges of infected persons.
3. Mode of Transmission. By drinking contaminated water, by eating infected foods, and by hand-to-mouth transfer of infected material; from objects soiled with discharges of an infected individual or of a carrier; by flies.
4. Incubation Period—Two to seven days.
5. Period of Communicability. During the febrile period of the disease and until the organism is absent from the bowel discharges.

6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by serological and bacteriological tests.

2. *Isolation*—Infected individuals during the communicable period of the disease.

3. *Immunization*—Vaccines give considerable immunity. Owing to severe reactions their use is not universal, nor should it be made compulsory except under extreme emergency.

4. *Quarantine*—None.

5. *Concurrent disinfection*—Bowel discharges.

6. *Terminal disinfection*—Cleaning.

(B) General measures—

1. Rigid personal prophylaxis of attendants upon infected persons.

2. No milk or food for human consumption should be sold from a place occupied by a patient unless the persons engaged therein occupy quarters separate from the house where the patient is sick, and all utensils used are cleaned and kept in a separate building and under a permit from the health officer.

3. All attendants upon persons affected with this disease should be prohibited from having anything to do with the handling of food.

4. Necessary precautions against flies.

5. Careful supervision of food and drink. Where dysentery is prevalent, only cooked foods should be used. Food and drink after cooking or boiling should be protected against contamination, as by flies and human handling.

Epidemic (Lethargic) Encephalitis

1. Infectious Agent. Unknown.
2. Source of Infection. Probably discharges from the nose and throat of infected persons, or articles freshly soiled therewith. It is supposed that there are healthy carriers during prevalence of the disease.
3. Mode of Transmission. Probably by direct contact with an infected person or a carrier of the virus, or by contact with articles freshly soiled with the discharges of the nose or throat of such persons.
4. Incubation Period. Undetermined. Believed to be about ten days.
5. Period of Communicability. Probably during the febrile stage of the disease.

6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease,* by clinical symptoms.
2. *Isolation* of recognized cases for one week after onset.
3. *Immunization*—None.
4. *Quarantine*—None.
5. *Concurrent disinfection*—Discharges of the nose and throat and articles soiled therewith.
6. *Terminal disinfection*—Cleaning.

(B) General measures—

1. Search for and examination of cases during periods of prevalence.
2. Isolation of suspected febrile cases pending diagnosis.

Favus

1. Infectious Agent. *Achorion schoenleinii.*
2. Source of Infection. Lesions of skin, particularly on scalp.
3. Mode of Transmission. Direct contact with patient, and indirectly through toilet articles.
4. Incubation Period. Unknown.
5. Period of Communicability. Until skin and scalp lesions are all healed.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms confirmed by microscopic examination of crusts.
2. *Isolation*—Exclusion of patient from school and other public places until lesions are healed.
3. *Immunization*—None.
4. *Quarantine*—None.
5. *Concurrent disinfection*—Toilet articles of patient.
6. *Terminal disinfection*—None.

(B) General measures—

1. Elimination of common utensils, such as hair brushes and combs.
2. Provision for adequate and intensive treatment and cure of cases of favus at hospitals and dispensaries, to abbreviate the period of infectivity of the patients.

German Measles (Rubella)

1. Infectious Agent. Unknown.
2. Source of Infection. Secretions of the mouth and possibly of the nose.

3. Mode of Transmission. By direct contact with the patient or with articles freshly soiled with the discharges from the nose or throat of the patient.
4. Incubation Period. From fourteen to twenty-one days.
5. Period of Communicability. Eight days from onset of the disease.
6. Methods of Control:
   (A) The infected individual and his environment—
      1. *Recognition of the disease*—Clinical symptoms.
      2. *Isolation*—Separation of the patient from nonimmune children, and exclusion of the patient from school and public places for the period of presumed infectivity.
      3. *Immunization*—None.
      4. *Quarantine*—None.
      5. *Concurrent disinfection*—Discharges from the nose and throat of the patient and articles soiled by discharges.
      6. *Terminal disinfection*—Airing and cleaning.
   (B) General measures—None.

Note—The reason for attempting to control this disease is that it may be confused with scarlet fever during its early stages; each person having symptoms of the disease should therefore be placed under the care of a physician and the case should be reported to the local department of health.

Glanders

1. Infectious Agent. Glanders bacillus, *Pfefferella mallei.*
2. Source of Infection. Discharges from open lesions of mucous membranes, or of the skin of human or equine cases of the disease (i.e., pus and mucus from the nose, throat, and bowel discharges from infected man and horse).
3. Mode of Transmission. Contact with a case or with articles freshly soiled by discharges from a human or equine case.
4. Incubation Period. Unknown.
5. Period of Communicability. Until bacilli disappear from discharges or until lesions have healed.
6. Methods of Control:
   (A) The infected individual and his environment—
      1. *Recognition of the disease*—By specific biological reactions, such as the complement-fixation test, the mallein test, the agglutination test, or by nonspecific reactions, such as the Straus reaction, if confirmed by culture, or by identification of the *Bacillus mallei*, or by autopsy of doubtful cases.
      2. *Isolation*—Human case at home or hospital; for infected horses destruction rather than isolation is advised. **Skin contact with the lesions in the living or dead body is to be scrupulously avoided.**

3. *Immunization*—None of established value or generally accepted.

4. *Quarantine* of all horses in an infected stable until all have been tested by specific reaction, and the removal of infected horses and terminal disinfection of stable have been accomplished.

5. *Concurrent disinfection*—Discharges from human cases and articles soiled therewith.

6. *Terminal disinfection*—Stables and contents where infected horses are found.

(B) General measures—

1. The abolition of the common drinking trough for horses.

2. Sanitary supervision of stables and blacksmith shops.

3. Semi-annual testing of all horses by a specific reaction where the disease is common.

4. Testing of all horses offered for sale where the disease is common.

NOTE—In this disease, as in all infectious or communicable diseases from which both animals and humans suffer, cases occurring in animals should be reported to the Department of Agriculture and human cases should be reported to the Department of Health, reciprocal notification thereafter to be accomplished through official interdepartment channels.

GONORRHEA

1. INFECTIOUS AGENT. Gonococcus, *Neisseria gonorrhoeae.*
2. SOURCE OF INFECTION. Discharges from lesions of inflamed mucous membranes and glands of infected persons, viz., urethral, vaginal, cervical, conjunctival mucous membranes, and Bartholin's or Skene's glands in the female, and Cowper's and the prostate glands in the male.
3. MODE OF TRANSMISSION. By direct personal contact with infected persons, and indirectly by contact with articles freshly soiled with the discharges of such persons.
4. INCUBATION PERIOD. One to eight days, usually three to five days.
5. PERIOD OF COMMUNICABILITY. As long as the gonococcus persists in any of the discharges, whether the infection be an old or a recent one.
6. METHODS OF CONTROL:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by bacteriological examination or serum reaction.

2. *Isolation*—When the lesions are in the genitourinary tract, exclusion from sexual contact, and when the lesions are conjunctival, exclusion from school or contact with children, as long as the discharges contain the infecting organism.

3. *Immunization*—None.

4. *Quarantine*—None.

5. *Concurrent disinfection*—Discharges from lesions and articles soiled therewith.

6. *Terminal disinfection*—None.

(B) General measures—

1. Education in matters of sexual hygiene, particularly as to the fact that continence in both sexes at all ages is compatible with health and normal development.

2. Provision for accurate and early diagnosis, and treatment in hospitals and dispensaries of infected persons, with consideration for privacy of record and provision for following cases until cured.

3. Repression of prostitution by use of police power and control of use of living premises.

4. Restriction of sale of alcoholic beverages.

5. Restriction of advertising of services or medicines for the treatment of sex diseases, etc.

6. Elimination of common towels and toilet articles from public places.

7. Use of prophylactic silver solution in the eyes of the newborn.

8. Exclusion of persons in the communicable stage of the disease from participation in the preparing and serving of food.

9. Personal prophylaxis should be advised to those who expose themselves to opportunity for infection.

Influenza

1. Infectious Agent. Undetermined.
2. Source of Infection. Probably discharges from the mouth and nose of infected persons and articles freshly soiled with such discharges.
3. Mode of Transmission. Believed to be by direct contact, by droplet infection or by articles freshly soiled with discharges of the nose and throat of infected persons.
4. Incubation Period. Short, usually twenty-four to seventy-two hours
5. Period of Communicability. Undetermined, apparently during the febrile period or at least for seven days from onset of clinical symptoms.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—By clinical symptoms only. Uncertain in inter-epidemic periods.

2. *Isolation*—During acute stage of disease.

3. *Immunization*—None; vaccines have not proved of definite value.

4. *Quarantine*—None.

5. *Concurrent disinfection*—Discharges from the nose and throat of the patient.

6. *Terminal disinfection*—Airing and cleaning.

(B) General measures—

During epidemics efforts should be made to reduce opportunities for direct-contact infection, as in crowded halls, stores, and street cars. Kissing, the use of common towels, glasses, eating utensils, or toilet articles should be avoided. The hands should be washed carefully before eating. In isolated towns and institutions, infection has been delayed and sometimes avoided by strict exclusion of visitors from already infected communities. The closing of schools has not been effective in checking the spread of infection. The use of masks by nurses and other attendants has proved of value in preventing infection in hospitals. Scrupulous cleanliness of dishes and utensils used in preparing and serving food in public eating places should be required, including the subjection of all such articles to disinfection in hot soapsuds. In groups which can be brought under daily professional inspection, the isolation of early and suspicious cases of respiratory tract inflammation, particularly when accompanied with a rise in temperature, may be relied upon to delay the spread of the disease. To minimize the severity of the disease and to reduce mortality, patients should go to bed at the beginning of an attack and not return to work without the approval of their physicians.

Leprosy

1. Infectious Agent. Leprosy bacillus, *Mycobacterium leprae.*
2. Source of Infection. Discharges from lesions.
3. Mode of Transmission. By close, intimate, and prolonged contact with infected individuals. Flies and other insects may be mechanical carriers.
4. Incubation Period. Prolonged, undetermined.
5. Period of Communicability. Infectivity exists throughout the duration of the disease. Where good standards of personal hygiene prevail, this disease is but slightly communicable.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by bacteriological examination.

2. *Isolation* for life in national leprosarium when this is possible, or at least until treatment has brought about a healing of all lesions of skin and mucous membranes and the patient has been observed with the disease in this arrested form for not less than six months.

3. *Immunization*—None.

4. *Quarantine*—None.

5. *Concurrent disinfection*—Discharges and articles soiled with discharges.

6. *Terminal disinfection*—Thorough cleansing of living premises of the patient.

(B) General measures—

1. Lack of information as to the determining factors in the spread and communication of the disease makes any but general advice in matters of personal hygiene of no value.

2. As a temporary expedient lepers may be properly cared for in local hospitals, or if conditions of the patient and his environment warrant, he may be allowed to remain on his own premises under suitable regulations.

Malaria

1. Infectious Agent. The several species of malarial organisms—*Plasmodium vivax* (tertian); *Plasmodium malariae* (quartan); *Laverania falciparum* (æstivo-autumnal).
2. Source of Infection. The blood of an infected individual.
3. Mode of Transmission. By bite of the infected Anopheles mosquitoes. The mosquito is infected by biting an individual suffering from acute or chronic malaria. The parasite develops in the body of the mosquito for from ten to fourteen days, after which time the sporozoites appear in its salivary glands.
4. Incubation Period. Varies with the type of species of infecting organism and the amount of infection; usually fourteen days in the tertian variety.
5. Period of Communicability. As long as the malaria organism exists in the blood.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, always to be confirmed by microscopical examination of the blood. Repeated examinations may be necessary.

2. *Isolation*—None except protection of the patient from approach of mosquitoes by screening his bed or room or house, until his blood is rendered free from malarial parasites by thorough treatment with quinine.

3. *Immunization*—None. The administration of prophylactic doses of quinine should be insisted upon for those constantly exposed to infection and unable to protect themselves against Anopheles mosquitoes.

4. *Quarantine*—None.

5. *Concurrent disinfection*—None. Destruction of Anopheles mosquitoes in the sick room.

6. *Terminal disinfection*—None. Destruction of Anopheles mosquitoes in the sick room.

(B) General measures—

1. Employment of known measures for destroying larvæ of anophelines and the eradication of breeding places of such mosquitoes.

2. Blood examination of persons living in infected centers to determine the incidence of infection.

3. Screening sleeping and living quarters; use of mosquito nets.

4. Killing mosquitoes in living quarters.

Malta Fever

1. Infectious Agent. *Micrococcus melitensis; Brucella melitensis; Alkaligenes melitensis; Alkaligenes abortus.*
2. Source of Infection. The milk and urine of infected goats, and the urine, blood, and milk of other infected domestic animals, mules, asses, horses, cows, oxen, hogs, sheep, rabbits, dogs, and fowls; the urine of infected persons and of carriers of the organism.
3. Mode of Transmission. By ingestion of milk from infected goats commonly; by direct contact with infected animals and persons and their urinary discharges in ways to permit the contamination of food and hands, occasionally; by inhalation of dust from soil or surfaces contaminated with urinary discharges of infected animals or persons, rarely; possibly by inoculation through abrasions of the skin by contaminated dust or soil, and by sexual intercourse with infected persons, and rarely by ingestion of infected cow's milk or by contact with infected blood or organs of domestic animals.
4. Incubation Period. Six to sixteen days.
5. Period of Communicability. From the onset of the disease until the organism is no longer found in the urine, usually ninety days, with a range of twenty to three hundred days.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—The clinical picture and particularly the undulant character of the fever, supplemented by

exact determination through the use of agglutination tests and bacteriological examination of the blood and urine for the infecting organism.

2. *Isolation* of infected individuals during the period of communicability.

3. *Immunization*—Preventive vaccination by suspensions of mixtures of the *Micrococcus melitensis* and *Micrococcus paramelitensis* have given good results. This is advised for exposed susceptibles, especially those handling goats in areas where the disease is known to exist. Autogenous vaccines have been used with but little success in the treatment of the disease.

4. *Quarantine*—None.

5. *Concurrent disinfection* of all discharges, especially the urine and of articles soiled with such discharges.

6. *Terminal disinfection*—Cleaning.

(B) General measures—

1. **Sterilization of goat's milk.**

2. Protection of public water supplies.

3. Supervision of human carriers and their exclusion from the handling of foods.

4. Destruction of infected animals.

5. Search for infection among goats by the serum and the lacto reaction (Zammit).

6. Immunization of goats by vaccines in areas where the disease is prevalent.

7. Exclusion of goats from areas of infection.

8. Sanitary supervision of goat shelters.

Measles

1. Infectious Agent. Unknown.
2. Source of Infection. Buccal and nasal secretions of an infected individual.
3. Mode of Transmission. Directly from person to person; indirectly through articles freshly soiled with the buccal and nasal discharges of an infected individual. The most easily transmitted of all communicable diseases.
4. Incubation Period. About ten days.
5. Period of Communicability. During the period of catarrhal symptoms and until the cessation of abnormal mucous membrane secretions—minimum period of nine days; from four days before to five days after the appearance of the rash.

C. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms. Special attention to rise of temperature, Koplik spots and catarrhal symptoms in exposed individuals.

2. *Isolation*—During period of communicability.

3. *Immunization*—By the use of the serum or whole blood of convalescent measles patients, or of any healthy adults who have had measles, given within five days after exposure to a known case of measles, the attack in the exposed person may be averted in a high percentage of instances; if not averted, the disease is modified. Given later, but at a time prior to the clinical onset of the disease, convalescent serum usually modifies the severity of the attack and the patient acquires the usual lasting immunity of the disease.

4. *Quarantine*—Exclusion of exposed susceptible school children and teachers from school until fourteen days from last exposure. This applies to exposure in the household. Exclusion of exposed susceptible children from all public gatherings for the same period.

5. *Concurrent disinfection*—All articles soiled with the secretions of the nose and throat.

6. *Terminal disinfection*—Thorough cleaning.

(B) General measures—

1. Daily examination of exposed children and of other possibly exposed persons. This examination should include record of the body temperature. A nonimmune exposed individual exhibiting a rise of temperature of 0.5° C. or more should be promptly isolated pending diagnosis.

2. Schools should not be closed or classes discontinued where daily observation of the children by a physician or nurse is provided for.

3. Education as to special danger of exposing young children to those exhibiting acute catarrhal symptoms of any kind.

4. In institutional outbreaks immunization with convalescent serum of all minor inmates who have not had measles is of value in checking the spread of infection and in reducing mortality.

Meningococcus Meningitis

1. Infectious Agent. Meningococcus; *Neisseria intracellularis.*

2. Source of Infection. Discharges from the nose and mouth of infected persons. Clinically recovered cases, and healthy persons who have never had the disease but have been in contact with cases of

the disease or other carriers, act as carriers and are commonly found, especially during epidemics. Such healthy carriers are not uncommonly found independent of epidemic prevalence of the disease.

3. Mode of Transmission. By direct contact with infected persons and carriers, and indirectly by contact with articles freshly soiled with the nasal and mouth discharges of such persons.
4. Incubation Period. Two to ten days, commonly seven. Occasionally for longer periods when a person is a carrier for a time before developing the disease.
5. Period of Communicability. During the clinical course of the disease and until the specific organism is no longer present in the nasal and mouth discharges of the patient. The same applies to healthy carriers so far as affects persistence of infectious discharges.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by the microscopic and bacteriological examination of the spinal fluid, and by bacteriological examination of nasal and pharyngeal secretions.

2. *Isolation* of infected persons until fourteen days after onset of the disease.

3. *Immunization* by the use of vaccines is still in the experimental stage.

4. *Quarantine*—None.

5. *Concurrent disinfection* of discharges from the nose and mouth and of articles soiled therewith.

6. *Terminal disinfection*—Cleaning.

(B) General measures—

1. Search for carriers among families and associates of recognized cases by bacteriological examination of posterior nares of all contacts.

2. Education as to personal cleanliness and necessity of avoiding contact and droplet infection.

3. Prevention of overcrowding such as is common in living quarters, transportation conveyances, working places, and places of public assembly in the civilian population, and in inadequately ventilated closed quarters in barracks, camps, and ships among military units.

(C) Epidemic measures—

1. Increase the separation of individuals and the ventilation in living and sleeping quarters for such groups of people as are especially exposed to infection because of their

occupation or some necessity of living conditions. Bodily fatigue and strain should be minimized for those especially exposed to infection.

2. Carriers should be quarantined until the nasal and pharyngeal secretions are proved by bacteriological examination to be free from the infecting organism.

Mumps

1. Infectious Agent. Unknown.
2. Source of Infection. Secretions of the mouth and possibly of the nose.
3. Mode of Transmission. By direct contact with an infected person or with articles freshly soiled with the discharges from the nose or throat of such infected person.
4. Incubation Period. From twelve to twenty-six days. The most common period, eighteen days, accepted as usual. A period of twenty-one days is not uncommon.
5. Period of Communicability. Unknown, but assumed to persist until the parotid gland has returned to its normal size.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Inflammation of Stenson's duct may be of assistance in recognizing the early stage of the disease. The diagnosis is usually made on swelling of the parotid gland.

2. *Isolation*—Separation of the patient from nonimmune children and exclusion of the patient from school and public places for the period of presumed infectivity. (See 5.)

3. *Immunization*—None.

4. *Quarantine*—None. Exposed susceptible persons should be regularly inspected for the onset, the presence of initial symptoms of the disease, such as fever, or swelling or pain of the parotid or adjacent lymph glands, for three weeks from the date of last exposure.

5. *Concurrent disinfection*—All articles soiled with the discharges from the nose and throat of the patient.

6. *Terminal disinfection*—None.

(B) General measures—

None.

Paratyphoid Fever

1. Infectious Agent. Paratyphoid bacillus A or B; *Salmonella paratyphi; Salmonella schottmulleri.*

2. Source of Infection. Bowel discharges and urine of infected persons, and foods contaminated with such discharges of infected persons or of healthy carriers. Healthy carriers may be numerous in an outbreak.
3. Mode of Transmission. Directly by personal contact; indirectly by contact with articles freshly soiled with the discharges of infected persons or through milk, water, or food contaminated by such discharges.
4. Incubation Period. Four to ten days; average, seven days.
5. Period of Communicability. From the appearance of prodromal symptoms, throughout the illness and relapses, during convalescence, and until repeated bacteriological examination of discharges show absence of the infecting organism.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by specific agglutination test, and by bacteriological examination of blood, bowel discharges, or urine.
2. *Isolation*—In fly-proof room, preferably under hospital conditions, of such cases as cannot command adequate sanitary environment and nursing care in their homes.
3. *Immunization* of exposed susceptibles.
4. *Quarantine*—None.
5. *Concurrent disinfection*—Disinfection of all bowel and urinary discharges and articles soiled with them.
6. *Terminal disinfection*—Cleaning.

(B) General measures—

1. Protection and purification of public water supplies.
2. Pasteurization of public milk supplies.
3. Supervision of other food supplies and of food handlers.[2]
4. Prevention of fly breeding.
5. Sanitary disposal of human excreta.
6. Extension of immunization by vaccination as far as practicable.
7. Supervision of paratyphoid carriers and their exclusion from the handling of foods.
8. Systematic examination of fecal specimens, from those who have been in contact with recognized cases, to detect carriers.
9. Exclusion of suspected milk supplies pending discovery of the personal or other cause of contamination of the milk.

[2]The human disease paratyphoid fever should not be confused with cases of food poisoning or infection due to enteritidis bacilli of animal origin.

10. Exclusion of water supply, if contaminated, until adequately treated with hypochlorite or other efficient disinfectant, or unless all water used for toilet, cooking, and drinking purposes is boiled before use.

Plague

(Bubonic, Septicemic, Pneumonic)

1. Infectious Agent. Plague bacillus; *Pasteurella pestis.*
2. Source of Infection. Blood of infected persons and animals, and sputum of human cases of plague pneumonia.
3. Mode of Transmission. Direct, in the pneumonic form. In other forms the disease is generally transmitted by the bites of fleas (*Xenopsylla cheopis* and *Ceratophyllus fasciatus*), by which the disease is carried from rats to man, also by fleas from other rodents. Accidental, by inoculation, or by the bites of infected animals. Bedbugs may transmit the infection; flies may possibly convey the infection.
4. Incubation Period. Commonly from three to seven days, although occasionally prolonged to eight or even fourteen days.
5. Period of Communicability. Until convalescence is well established, period undetermined.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by bacteriological examination of blood, pus from glandular lesions, or sputum. Animal inoculation of material from suspected cases.

2. *Isolation*—Patient in hospital if practicable; if not, in a screened room which is free from vermin.[3]

3. *Immunization*—Active immunization of those who may be exposed.

4. *Quarantine*—Contacts for seven days.

5. *Concurrent disinfection*—All discharges and articles freshly soiled therewith.

6. *Terminal disinfection*—Thorough cleaning followed by thorough disinfection.

(B) General measures—

1. Extermination of rats and vermin by use of known methods for their destruction; destruction of rats on ships arriving

[3]In plague pneumonia, personal prophylaxis, to avoid droplet infection must be carried out by persons who come in contact with the sick. Masks of closely woven cloth with mica windows should be worn over the head and to the shoulders. A long gown and rubber gloves drawn over the sleeves of the gown should be provided. These articles should not be removed from the sick room until disinfected.

from infected ports; examination of rats, ground squirrels, etc., in areas where the infection persists, for evidence of endemic or epidemic prevalence of the disease among them.

2. Supervision of autopsies of all deaths during epidemics.

3. Supervision of the disposal of the dead during epidemics, whether by burial, transfer, or holding in vault, whatever the cause of death.

4. Cremation, or burial in quicklime, of those dying of this disease.

Pneumonia

Acute Lobar

1. Infectious Agent. Various pathogenic bacteria commonly found in the nose, throat, and mouth, such as the pneumococcus, the bacillus of Friedlander, the influenza bacillus, etc.
2. Source of Infection. Discharges from the mouth and nose of apparently healthy carriers, as well as of recognized infected individuals, and articles freshly soiled with such discharges.
3. Mode of Transmission. By direct contact with an infected person, or with articles freshly soiled with the discharges from the nose or throat of, and possibly from infected dust of rooms occupied by infected persons.
4. Incubation Period. Short, usually two to three days.
5. Period of Communicability. Unknown; presumably until the mouth and nasal discharges no longer carry the infectious agent in an abundant amount or in a virulent form.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms. Specific infecting organisms may be determined by serological and bacteriological tests early in the course of the disease.

2. *Isolation*—Patient during clinical course of the disease.

3. *Immunization*—None; vaccines are worthy of further careful trial.

4. *Quarantine*—None.

5. *Concurrent disinfection*—Discharges from the nose and throat of the patient.

6. *Terminal disinfection*—Thorough cleaning, airing and sunning.

(B) General measures—

In institutions and camps, when practicable, people in large numbers should not be congregated closely within doors. The

general resistance should be conserved by good feeding, fresh air, temperance in the use of alcoholic beverages, and other hygienic measures.

NOTE—The early reporting of pneumonia is highly desirable in view of its communicability.

POLIOMYELITIS

1. INFECTIOUS AGENT. A filterable virus of undetermined morphology.
2. SOURCE OF INFECTION. Nose, throat, and bowel discharges of infected persons or articles recently soiled therewith. Healthy carriers are supposed to be common.
3. MODE OF TRANSMISSION. By direct contact with an infected person or with a carrier of the virus, or indirectly by contact with articles freshly soiled with the nose, throat, or bowel discharges of such persons, and probably by drinking milk contaminated by the nose, mouth and bowel discharges of persons in the active stage of the disease.
4. INCUBATION PERIOD. Uncertain because of inexact information as to period of communicability and essentials for exposure, but believed to be from three to ten days, commonly six days.
5. PERIOD OF COMMUNICABILITY. Unknown; apparently not more than twenty-one days from the onset of disease, but may precede onset of clinical symptoms by several days.
6. METHODS OF CONTROL:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, assisted by chemical and microscopical examination of the spinal fluid.
2. *Isolation* of all recognized cases for three weeks from febrile onset.
3. *Immunization*—None.
4. *Quarantine* of exposed children of the household and of adults of the household whose vocation brings them into contact with children, or who are food handlers, for fourteen days from last exposure to a recognized case.
5. *Concurrent disinfection*—Nose, throat, and bowel discharges and articles soiled therewith.
6. *Terminal disinfection*—Cleaning.

(B) General measures during epidemics—

1. Search for and examination of all sick children should be made.
2. All children with fever should be isolated pending diagnosis.
3. Education in such technique of bedside nursing as will prevent the distribution of infectious discharges to others from cases isolated at home.

Rabies

1. Infectious Agent. Unknown.
2. Source of Infection. Saliva of infected animals, chiefly dogs.
3. Mode of Transmission. Inoculation with saliva of infected animals through abrasion of skin or mucous membrane, almost always by bites or scratches.
4. Incubation Period. Usually two to six weeks. May be prolonged to six months or even longer.
5. Period of Communicability. For fifteen days in the dog (not known in man) before the onset of clinical symptoms and throughout the clinical course of the disease.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by the presence of Negri bodies in the brain of an infected animal, or by animal inoculations with material from the brain of such infected animal.

2. *Isolation*—None if patient is under adequate medical supervision, and the immediate attendants are warned of possibility of inoculation by human virus.

3. *Immunization*—Preventive vaccination after exposure to infection by inoculation.

4. *Quarantine*—None.

5. *Concurrent disinfection* of saliva of patient and articles soiled therewith.

6. *Terminal disinfection*—Thorough cleaning.

(B) General measures—

1. Muzzling of dogs when on public streets, or in places to which the public has access.

2. Detention and examination of dogs suspected of having rabies.

3. Immediate antirabic treatment of people bitten by dogs or by other animals suspected or known to have rabies, unless the animal is proved not to be rabid by subsequent observation or by microscopic examination of the brain and cord.

4. Annual immunization of dogs where the disease is prevalent.

Rocky Mountain Spotted or Tick Fever

1. Infectious Agent. *Dermacentroxenus Rickettsii* according to Wolbach.
2. Source of Infection. Blood of infected animals, and infected ticks *(Dermacentor andersoni)*.

3. Mode of Transmission. By bites of infected ticks, and in the laboratory, by handling infected tissues of ticks and animals.
4. Incubation Period. Three to ten days, usually seven days.
5. Period of Communicability. There is no authentic record of the transfer of the disease from man to man. Ticks may acquire the infection from infected rodents during the febrile stage.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—By clinical symptoms of the disease in areas where the disease is known to be endemic.

2. *Isolation*—None, other than care exercised to protect patients from tick bites when in endemic areas.

3. *Immunization*—The use of the Spencer-Parker vaccine in infected areas has given generally favorable results, but is still in the experimental stage.

4. *Quarantine*—None.

5. *Concurrent disinfection*—None. All ticks on the patient should be destroyed.

6. *Terminal disinfection*—None.

(B) General measures—

1. Personal prophylaxis of persons entering the infected zones during the season of ticks, by wearing tick-proof clothing, and careful daily search of the body for ticks which may have attached themselves.

2. The destruction of ticks by clearing and burning vegetation on the land in infected zones.

3. The destruction of ticks on domestic animals by dipping.

4. The destruction of small mammalian hosts, as ground squirrels, chipmunks, etc.

Scarlet Fever

1. Infectious Agent. *Streptococcus scarlatinae.*
2. Source of Infection. Discharges from the nose, throat, ears, abscesses or wound surfaces, and articles freshly soiled therewith. The nose and throat discharges of carriers may also spread the disease.
3. Mode of Transmission. Directly by personal contact with an infected person; indirectly by articles freshly soiled with discharges of an infected person, or through contaminated milk, or milk products.
4. Incubation Period. Two to seven days, usually three or four days.
5. Period of Communicability. Three weeks from the onset of the disease, without regard to the stage or extent of desquamation, and

only after all abnormal discharges have ceased and all open sores or wounds have healed.

6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—By clinical symptoms.

2. **Isolation—In home or hospital, maintained in each case until the end of the period of infectivity.** If medical inspection is not available, isolation for twenty-eight days from onset.

3. *Immunization*—Exposed susceptibles as determined by the Dick test may be actively immunized by scarlet fever toxin.

4. *Quarantine*—Exclusion of exposed children and teachers from school, and food handlers from their work, until seven days have elapsed since last exposure to a recognized case.

5. *Concurrent disinfection*—Of all articles which have been in contact with a patient and all articles soiled with discharges of the patient.

6. *Terminal disinfection*—Thorough cleaning.

(B) General measures—

1. Daily examination of exposed children and of other possibly exposed persons for a week after last exposure.

2. Schools should not be closed where daily observation of the children by a physician or nurse can be provided for.

3. In school and institutional outbreaks immunization of all exposed children with scarlet fever toxin may be advisable.

4. Education as to special danger of exposing young children to those exhibiting acute catarrhal symptoms of any kind.

5. Pasteurization of milk supply.

Septic Sore Throat

1. Infectious Agent. Streptococcus (hemolytic type).

2. Source of Infection. The human nasopharynx, usually the tonsils, any case of acute streptococcus inflammation of these structures being a potential source of infection, including the period of convalescence of such cases. The udder of a cow infected by the milker is a common source of infection. In such udders the physical signs of mastitis may be absent.[4]

3. Mode of Transmission. Direct or indirect human contact; consumption of raw milk contaminated by case or carrier or from an infected udder.

4. Incubation Period. One to three days.

[4]Mastitis in the cow, due to bovine streptococci, is not a cause of septic sore throat in humans unless a secondary infection of the udder by a human type of streptococcus takes place.

5. Period of Communicability. In man, presumably during the continuance of clinical symptoms; in the cow, during the continuance of discharge of the streptococci in the milk, the condition in the udder tending to a spontaneous subsidence. The carrier stage may follow convalescence and persist for some time.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms. Bacteriological examination of the lesions or discharges from the tonsils and nasopharynx may be useful.

2. *Isolation*—During the clinical course of the disease and convalescence, and particularly exclusion of the patient from participation in the production or handling of milk or milk products.

3. *Immunization*—None.

4. *Quarantine*—None.

5. *Concurrent disinfection*—Articles soiled with discharges from the nose and throat of the patient.

6. *Terminal disinfection*—Cleaning.

(B) General measures—

1. Exclusion of suspected milk supply from public sale or use, until pasteurized. The exclusion of the milk of an infected cow or cows in small herds is possible when based on bacteriological examination of the milk of each cow, and preferably the milk from each quarter of the udder at frequent intervals. Exclusion of human cases or carriers from handling milk or milk products.

2. Pasteurization of all milk.

3. Education in the principles of personal hygiene and avoidance of the use of common towel, drinking and eating utensils.

Smallpox

1. Infectious Agent. Unknown.
2. Source of Infection. Lesions of the mucous membranes and skin of infected persons.
3. Mode of Transmission. By direct personal contact; by articles soiled with discharges from lesions. The virus may be present in all body discharges, including feces and urine. It may be carried by flies.
4. Incubation Period. Eight to sixteen days. (Cases with incubation period of twenty-one days are reported.)
5. Period of Communicability. From first symptoms to disappearance of all scabs and crusts.

6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms. Tests for immunity may prove useful.

2. *Isolation*—**Hospital isolation in screened wards, free from vermin, until the period of infectivity is over.**

3. *Immunization*—**Vaccination.**

4. **Quarantine**—Isolation of all contacts until vaccinated with virus of full potency. Daily medical observation of all recently vaccinated contacts until height of reaction is passed, if vaccination was performed within twenty-four hours of first exposure, otherwise for sixteen days from last exposure.

5. **Concurrent disinfection of all discharges.** No article to leave the surroundings of the patient without boiling or equally effective disinfections.

6. *Terminal disinfection*—Thorough cleaning and disinfection of premises.

(B) General measures—

General vaccination in infancy, revaccination of children on entering school, and of entire population when the disease appears in a severe form.

Note—In order to avoid possible complications or secondary and subsequent infections at the site of vaccination, it is important that the vaccination insertion be as small as practicable, not over one-eighth inch in any direction, and that the site be kept dry and cool. The prick-pressure method as recommended by the United States Public Health Service, or the single scratch method is preferred. Primary vaccination between the ages of two and three months is particularly desirable. The time of vaccination should be adjusted to avoid skin lesions elsewhere on the body, in infants to avoid teething, and in older children to avoid the warmer months. Particular care should be used in primary vaccinations beyond the age of infancy.

Syphilis

1. Infectious Agent. *Treponema pallidum.*
2. Source of Infection. Discharges from the lesions of the skin and mucous membranes, and the blood of infected persons, and articles freshly soiled with such discharges or blood in which the *Treponema pallidum* is present.
3. Mode of Transmission. By direct personal contact with infected persons, and indirectly by contact with discharges from lesions or with the blood of such persons.
4. Incubation Period. About three weeks. (In rare instances reported to have been as long as seventy days.)
5. Period of Communicability. As long as the lesions are open upon the skin, or mucous membranes at any stage of the disease.

6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by microscopical examination of discharges and by serum reactions.

2. *Isolation*—Exclusion from sexual contact and from preparation or serving of food during the early and active period of the disease; otherwise, none, unless the patient is unwilling to heed, or is incapable of observing, the precautions required by the medical advisor.

3. *Immunization*—None.

4. *Quarantine*—None.

5. *Concurrent disinfection* of discharges and of articles soiled therewith.

6. *Terminal disinfection*—None.

(B) General measures—

1. Education in matters of sexual hygiene, particularly as to the fact that continence in both sexes and at all ages is compatible with health and normal development.

2. Provision for accurate and early diagnosis and treatment, in hospitals and dispensaries, of infected persons, with consideration for privacy of record, and provision for following cases until cured.

3. Repression of prostitution by use of the police power and control of use of living premises.

4. Restriction of sale of alcoholic beverages.

5. Restriction of advertising of services or medicines for treatment of sex diseases, etc.

6. Abandonment of the use of common towels, cups, and toilet articles and eating utensils.

7. Exclusion of persons in the communicable stage of the disease from participation in the preparing and serving of food.

8. Personal prophylaxis should be advised to those who expose themselves to opportunity to infection.

Tetanus

1. Infectious Agent. Tetanus bacillus; *Clostridium tetani.*
2. Source of Infection. Animal manure, soil, and street dust.
3. Mode of Transmission. Inoculation, or wound infection.
4. Incubation Period. Four days to three weeks, or longer, if latent bacilli deposited in the tissues are stirred to activity by subsequent chemical or mechanical irritation. Commonly eight to ten days.

5. Period of Communicability. Patient not infectious except in rare instances where wound discharges are infectious.
6. Methods of Control:
   (A) The infected individual and his environment—
      1. *Recognition of the disease*—Clinical symptoms; may be confirmed bacteriologically.
      2. *Isolation*—None.
      3. *Immunization*—By at least one, and preferably two, injections of antitoxin.
      4. *Quarantine*—None.
      5. *Concurrent disinfection*—None.
      6. *Terminal disinfection*—None.
   (B) General measures—
      1. Supervision of the practice of obstetrics.
      2. Educational propaganda such as "safety-first" campaign, and "safe and sane Fourth of July" campaign.
      3. Prophylactic use of tetanus antitoxin where wounds have been acquired in regions where the soil is known to be heavily contaminated, and in all cases where wounds are ragged or penetrating.
      4. Removal of all foreign matter as early as possible from all wounds.
      5. Supervision of biological products, especially vaccines and sera.

Trachoma

1. Infectious Agent. Undetermined.
2. Source of Infection. Secretions and purulent discharges from the conjunctivæ and adnexed mucous membranes of the infected persons.
3. Mode of Transmission. By direct contact with infected persons and indirectly by contact with articles freshly soiled with the infective discharges of such persons.
4. Incubation Period. Undetermined.
5. Period of Communicability. During the persistence of lesions of the conjunctivæ and of the adnexed mucous membranes or of discharges from such lesions.
6. Methods of Control:
   (A) The infected individual and his environment—
      1. *Recognition of the disease*—Clinical symptoms. Bacteriological examination of the conjunctival secretions and lesions may be useful.
      2. *Isolation*—Exclusion of the patient from general school classes.

3. *Immunization*—None.

4. *Quarantine*—None.

5. *Concurrent disinfection* of discharges and articles soiled therewith.

6. *Terminal disinfection*—None.

(B) General measures—

1. Search for cases by examination of school children, of immigrants, and among the families and associates of recognized cases; in addition, search for acute secreting disease of conjunctivæ and adnexed mucous membranes, both among school children and in their families, and treatment of such cases until cured.

2. Elimination of common towels and toilet articles from public places.

3. Education in the principles of personal cleanliness and the necessity of avoiding direct or indirect transference of body discharges.

4. Control of public dispensaries where communicable eye diseases are treated.

Trichinosis

1. Infectious Agent. *Trichinella spiralis.*
2. Source of Infection. Uncooked or insufficiently cooked meat of infected hogs.
3. Mode of Transmission. Consumption of undercooked infected pork products.
4. Incubation Period. Variable; usually about one week.
5. Period of Communicability. Disease is not transmitted by human host.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by microscopical examination of muscle tissue containing trichinæ.

2. *Isolation*—None.

3. *Immunization*—None.

4. *Quarantine*—None.

5. *Concurrent disinfection*—Sanitary disposal of the feces of the patient.

6. *Terminal disinfection*—None.

(B) General measures—

1. Inspection of pork products for the detection of trichinosis.

2. Thorough cooking of all pork products at a temperature of 160° F. or over.

Tuberculosis (Pulmonary)

1. Infectious Agent. Tubercle bacillus (human), *Mycobacterium tuberculosis (hominis)*.
2. Source of Infection. The specific organism present in the discharges, or articles freshly soiled with the discharges from any open tuberculous lesions, the most important discharge being sputum. Of less importance are discharges from the intestinal and genitourinary tracts, or from lesions of the lymphatic glands, bone, and skin.
3. Mode of Transmission. Direct or indirect contact with an infected person by coughing, sneezing, or other droplet infection, kissing, common use of unsterilized food utensils, pipes, toys, drinking cups, etc., and possibly by contaminated flies and dust.
4. Incubation Period. Variable and dependent upon the type of the disease.
5. Period of Communicability. Exists as long as the specific organism is eliminated by the host. Commences when a lesion becomes an open one—i.e., discharging tubercle bacilli, and continues until it heals or death occurs.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—By thorough physical examination supplemented by use of the x-ray and specific skin reactions when necessary and confirmed by bacteriological examinations of sputum or other materials.
2. *Isolation* of such "open" cases as do not observe the precautions necessary to prevent the spread of the disease.
3. *Immunization*—None.
4. *Quarantine*—None.
5. *Concurrent disinfection* of sputum and articles soiled with it. Particular attention should be paid to prompt disposal or disinfection of sputum itself, of handkerchiefs, cloths, or paper soiled therewith, and of eating utensils used by the patient.
6. *Terminal disinfection*—Cleaning and renovation.

(B) General measures—

1. Education of the public in regard to the dangers of tuberculosis and the methods of control, with especial stress upon the danger of exposure and infection in early childhood.
2. Provision of dispensaries and visiting-nurse service for discovery of early cases and supervision of home cases.
3. Provision of hospitals for isolation of advanced cases, and sanatoria for the treatment of early cases.
4. Provision of open-air schools and preventoria for pretuberculous children.

5. Improvement of housing conditions and the nutrition of the poor.

6. Ventilation and elimination of dust in industrial establishments and places of public assembly.

7. Improvement of habits of personal hygiene and betterment of general living conditions.

8. Separation of babies from tuberculous mothers at birth.

Tuberculosis (other than Pulmonary)

1. Infectious Agent. Tubercle bacillus (human and bovine), *Mycobacterium tuberculosis (hominis et bovis)*.
2. Source of Infection. Discharges from mouth, nose, bowels, and genitourinary tract of infected humans; articles freshly soiled with such discharges; milk from tuberculous cattle; rarely the discharging lesion of bones, joints, and lymph nodes.
3. Mode of Transmission. By direct contact with infected persons, by contaminated food, and possibly by contact with articles freshly soiled with the discharges of infected persons.
4. Incubation Period. Unknown.
5. Period of Communicability. Until lesions are healed.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms confirmed by bacteriological and serological examinations.

2. *Isolation*—None.

3. *Immunization*—None.

4. *Quarantine*—None.

5. *Concurrent disinfection*—Discharges and articles freshly soiled with them.

6. *Terminal disinfection*—Cleaning.

(B) General measures—

1. Pasteurization of milk and inspection of meats.

2. Eradication of tuberculous cows from milch herds used in supplying raw milk.

3. Patients with open lesions should be prohibited from handling foods which are consumed raw.

Tularemia

1. Infectious Agent. *Bacterium tularense; Pasteurella tularensis.*
2. Source of Infection. Wild rabbits and ground squirrels; also infected laboratory animals—infected flies (*Chrysops discalis*) and ticks (*Dermacentor andersoni*).

3. Mode of Transmission. By bites of infected flies and ticks and by inoculation through handling infected animals, as in dressing rabbits for market and cooking, or in performing necropsies on infected laboratory animals. Eye infections have been caused by contamination of the conjunctival sac with portions of the internal organs or with the body fluids of infected flies, ticks, and wild rabbits.
4. Incubation Period. From twenty-four hours to nine days; average slightly more than three days.
5. Period of Communicability. There is no authentic record of transfer of the disease from man to man. The infection has been found in the blood during the first two weeks; in conjunctival scrapings and in lymph glands up to seventeen days; in the spleen taken at autopsy up to twenty-six days. Flies are infective for fourteen days, ticks throughout their lifetime. Refrigerated wild rabbits are infective for three weeks.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—By clinical symptoms of the disease, by animal inoculation of infected material, and by agglutination reactions.
2. *Isolation*—None.
3. *Immunization*—None.
4. *Quarantine*—None.
5. *Concurrent disinfection*—Disinfection of discharges from the ulcer, lymph glands, or conjunctival sac.
6. *Terminal disinfection*—None.

(B) General measures—

1. Avoidance of the bites of, or handling of, flies and ticks when working in the infected zones during the seasonal incidence of the deer fly and tick.
2. The use of rubber gloves by persons engaged in dressing wild rabbits wherever taken, or when performing necropsies on infected laboratory animals. Employment of immune persons for dressing wild rabbits or conducting laboratory experiments. Thorough cooking of meat of wild rabbits.

Typhoid Fever

1. Infectious Agent. Typhoid bacillus, *Eberthella typhi.*
2. Source of Infection. Bowel discharges and urine of infected individuals. Healthy carriers are common.
3. Mode of Transmission. Conveyance of the specific organism by direct or indirect contact with a source of infection. Among indirect means of transmission are contaminated water, milk, and

shellfish. Contaminated flies have been common means of transmission in epidemics.

4. INCUBATION PERIOD. From seven to twenty-three days, averaging ten to fourteen days.

5. PERIOD OF COMMUNICABILITY. From the appearance of prodromal symptoms, throughout the illness and relapses during convalescence, and until repeated bacteriological examinations of the discharges show persistent absence of the infecting organism.

6. METHODS OF CONTROL:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms, confirmed by specific agglutination test and bacteriological examination of blood, bowel discharges, or urine.

2. *Isolation*—In fly-proof room, preferably under hospital conditions, of such cases as cannot command adequate sanitary environment and nursing care in their homes. Release from isolation should be determined by two successive negative cultures of stool and urine specimens collected not less than twenty-four hours apart.

3. *Immunization*—Of susceptibles in the family or household of the patient who have been exposed, or may be exposed during the course of the disease.

4. *Quarantine*—None.

5. Concurrent disinfection—Disinfection of all bowel and urinary discharges and articles soiled with them.

6. *Terminal disinfection*—Cleaning.

(B) General measures—

1. Protection and purification of public water supplies.

2. Pasteurization of public milk supplies.

3. Supervision of other food supplies, and of food handlers.

4. Prevention of fly breeding.

5. Sanitary disposal of human excreta.

6. Extension of immunization by vaccination as far as practicable in communities where the disease is prevalent.

7. Supervision of typhoid carriers and their exclusion from the handling of foods.

8. Systematic examination of fecal specimens from those who have been in contact with recognized cases, to detect carriers.

9. Persons who fail to show a strongly positive Widal reaction and contemplate traveling, should protect themselves by vaccination.

10. Exclusion of suspected milk supplies pending discovery of the person or other cause of contamination of the milk.

11. Exclusion of water supply, if contaminated, until adequately treated with hypochlorite or other efficient disinfectant, or unless all water used for toilet, cooking, and drinking purposes is boiled before use.

Typhus Fever

1. Infectious Agent. *Rickettsia prowazeki* is believed to be the causative agent.
2. Source of Infection. The blood of infected individuals.
3. Mode of Transmission. Infectious agent transmitted by lice. (*Pediculus corporis, P. capitis.*)
4. Incubation Period. Five to twenty days, usually twelve days.
5. Period of Communicability. Until thirty-six hours have elapsed after the temperature reaches normal.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms. Confirmation by agglutination tests ("Weil-Felix" reactions).

2. **Isolation—In a vermin-free room. All attendants should wear vermin-proof clothing.**

3. *Immunization*—Methods for immunization not generally accepted.

4. *Quarantine*—Exposed susceptible for fourteen days after last exposure.

5. *Concurrent disinfection*—None.

6. *Terminal disinfection*—Destroy all vermin and vermin eggs on body of patient, if not already accomplished. Destroy all vermin and eggs on clothing. Rooms to be rendered free from vermin.

(B) General measures—

Delousing of persons, clothing, and premises during epidemics, or when they have come or have been brought into an uninfected place from an infected community.

Whooping Cough

1. Infectious Agent. Pertussis bacillus of Bordet and Gengou, *Hemophilus pertussis.*
2. Source of Infection. Discharges from the laryngeal and bronchial mucous membranes of infected persons (rarely also of infected dogs and cats, which are known to be susceptible).
3. Mode of Transmission. Contact with an infected person or animal or with articles freshly soiled with the discharges of such persons or animals.

4. Incubation Period. Commonly seven days, almost uniformly within ten days.
5. Period of Communicability. Particularly communicable in the early catarrhal stages before the characteristic whoop makes a clinical diagnosis possible. The catarrhal stage occupies from seven to fourteen days. After the characteristic whoop has appeared the communicable period continues certainly for three weeks. Even if the spasmodic cough with whoop persists longer than this it is most unlikely that the infecting organism can be isolated from the discharges. The communicable stage must be considered to extend from seven days after exposure to an infected individual to three weeks after the development of the characteristic whoop.
6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical leucocyte count, and confirmed where possible by bacteriological examination of bronchial secretions. A positive diagnosis may be made by bacteriological examination of laryngeal discharges as early as one week before the development of the characteristic whoop.

2. **Isolation—Separation of the patient from susceptible children, and exclusion of the patient from school and public places for the period of presumed infectivity.**

3. *Immunization*—Use of prophylactic vaccination recommended by some observers. Not effective in all cases.

4. *Quarantine*—Limited to the exclusion of nonimmune children from school and public gatherings for ten days after their last exposure to a recognized case.

5. *Concurrent disinfection*—Discharges from the nose and throat of the patient and articles soiled with such discharges.

6. *Terminal disinfection*—Cleaning of the premises used by the patient.

(B) General measures—

Education in habits of personal cleanliness and in the dangers of association or contact with those showing catarrhal symptoms with a cough.

Yellow Fever

1. Infectious Agent. Unknown.
2. Source of Infection. The blood of infected persons.
3. Mode of Transmission. By the bite of infected *Aedes aegypti* mosquitoes.
4. Incubation Period. Three to five days, occasionally six days.
5. Period of Communicability. First three days of the fever.

6. Methods of Control:

(A) The infected individual and his environment—

1. *Recognition of the disease*—Clinical symptoms.

2. Isolation—Isolate from mosquitoes in a special hospital ward or thoroughly screened room. If necessary the room or ward should be freed from mosquitoes by fumigation. Isolation necessary only for the first three days of the fever.

3. *Immunization*—None.

4. *Quarantine*—Contacts for six days.

5. *Concurrent disinfection*—None.

6. *Terminal disinfection*—None. Upon termination of case the premises should be rendered free from mosquitoes by fumigation.

(B) General measures—

Eliminate mosquitoes by rendering breeding impossible.

(C) Epidemic measures—

1. Inspection service for the detection of those ill with the disease.

2. Fumigation of houses in which cases of disease have occurred and of all adjacent houses.

3. Destruction of Aedes ægypti mosquitoes by fumigation; use of larvicides; eradication of breeding places.

APPENDIX B

DISINFECTION AND DISINFECTANTS

The purpose of adding this appendix is to give a brief statement of the chemical and physiological principles involved in the action of the various disinfectants and certain facts relative to their use, which may be convenient for the reference of the average individual.

Definitions.—A few definitions will be necessary as a basis for discussion.

Disinfection means the destruction of the agents causing infection.

Sterilization refers to the destruction of all forms of life in a certain medium or location.

Sepsis is a bacteriological process of decay.

Antiseptics are substances which prevent decomposition and decay. They do not necessarily destroy the organisms.

Asepsis is the absence of living organisms.

A *germicide* is a substance which has the power of destroying germs.

A *deodorant* is a substance which destroys or neutralizes the odors arising from the putrefaction or fermentation of organic substances.

Disinfection Versus Sterilization.—Most organisms which produce disease are not spore-forming and it is, therefore, possible to disinfect in most instances without complete sterilization. Material containing the bacilli of tetanus and anthrax or the bacillus of malignant edema or B. welchii requires sterilization because these bacilli form spores.

Dry heat at a temperature of 160° C. or a temperature of 150° C. maintained for one hour will kill spores. Steam

under a pressure of 15 pounds per square inch will kill spores in fifteen minutes. Steam at 15 lbs. pressure has a temperature of about 120° C.

Antiseptics.—Sugar and salt are the ordinary household antiseptics. These substances like freezing or drying prevent the development of the microorganisms which may still remain alive. Weak solutions of certain disinfectants like mercury bichloride are antiseptic substances.

Deodorants.—Dryness is the great natural deodorant. Substances which are thoroughly dried will not give off disagreeable smells. An example of this is seen in the sanitary dry privy. Dryness sufficient to deodorize, however, is not sufficent to sterilize or disinfect.

Of the chemical substances formaldehyde is an excellent deodorant as well as germicide since it combines directly with the putrefactive substances to form new substances which are not malodorants.

Fumigation.—Fumigation is a process of liberating gases or fumes for the purpose of destroying the causes of infection or possible carriers of infection. Fumigation may therefore be directed either against germs or against insects and other animals which spread disease. It is now chiefly used to kill insects and other animals. There is a wide difference between fumigation and disinfection and the two words should not be used interchangeably. The ordinary fumigants are formaldehyde gas, sulphur dioxide (SO_2), hydrocyanic acid (HCN), the halogens, carbon bisulphide (CS_2), carbon tetrachloride (CCl_4), and pyrethrum.

Disinfection.—It is important to know what to disinfect, how to disinfect, and when to disinfect in order that the work may be done efficiently and completely. Bedside and continuous disinfection is far more important than terminal fumigation in preventing the spread of disease. In controlling any communicable disease the causative organism and modes of transmission should be thoroughly understood.

Control of Disinfection.—The efficiency of a disinfecting process may be determined by saturating cotton threads with a culture of B. prodigiosus, grown in Dunham's Peptone Medium. These threads are subjected to the process of disinfection with the other material, then planted in tubes of sterile broth where growth may be readily determined by the development of red color.

Natural Disinfection.—Nature's disinfecting agencies include (1) dilution, as exemplified by the purification of pollution in water, (2) sunlight, which kills organisms by its actinic rays; (3) dryness if sufficient and prolonged and (4) symbiosis, as exemplified in the destruction of disease germs in sewage by the action of the bacteria of putrefaction.

The Ideal Disinfectant has not yet been found. Such a substance would be highly germicidal, free from organic matter, reasonably stable, soluble or readily miscible in water forming a permanent emulsion; it should be harmless to man and the higher animals, possessed of a good power of penetration without bleaching fabrics or pigments and corroding metals.

Standardizing Disinfectants.—In order that we may have a terminology by which the disinfecting power of a substance may be stated there has been developed a method of standardizing disinfectants by comparing them with phenol. By this comparison the so-called *carbolic coefficient* is determined. This states the germicidal power of the given substance as compared with that of 5% carbolic acid.

The test is limited to the effect of the germicide upon naked bacterial cells under favorable conditions for action. The time is constant and the strength of the disinfectant is varied. A 24-hour culture of B. typhosus, grown in bouillon after having been transplanted for three successive days, is used as a test organism.

The steps in making the *Rideal-Walker test* for standardizing disinfectants are as follows:

(1) Make up Standard solution of 5% phenol.

(2) Prepare three test tubes using 5 c.c. of this in the following dilutions: 1 to 90, 1 to 100, 1 to 110. Tubes 1 inch in diameter are used.

(3) Various dilutions of the substance to be tested are made (5 c.c. being used in each test tube).

(4) All solutions as well as the cultures are brought to 20° C. on a water bath.

(5) Add 0.1 c.c. of culture to each tube at intervals of 30 sec. (Use tubes in groups of 5.)

(6) At end of 2½ minutes begin to transplant with a standard loop (4 mm. No. 14 wire U. S. Gauge) to broth culture. Transplant from each tube at the end of 2½ minute period.

(7) Make a second transplanting from each tube when it has been exposed 5 minutes.

(8) Incubate transplants 48 hours at 37° C. and read plus or minus. The carbolic coefficient is the factor obtained by dividing the lowest dilution of the unknown disinfectant which permitted growth of both the 2½ and 5 minutes exposure by the lowest dilution of the phenol which gave the same result.

Physical Agents of Disinfection.—The following list enumerates the physical means of disinfection with the briefest comment as to their use and efficiency.

(1) *Sunlight* is an active germicide. It destroys spores as well as bacteria. The blue-violet and ultra-violet rays possess germicidal power.

(2) *Ultra-Violet Rays* kill spores and vegetative cells.

(3) *Electricity* may kill germs either by thermal or electrolytic action but it is not adapted to general or practical use.

(4) *Burning* is best for those things which may be destroyed.

(5) *Dry heat,* 150° C. for one hour will destroy both vegetative cells and spores. Dry heat lacks penetration and is injurious to fabrics.

(6) *Boiling* is very effective, and is particularly applicable to the disinfection of bedding, body linen, towels, fabrics of many kinds, kitchen and table ware, cuspidors, etc. The efficacy of boiling water is increased by the addition of alcohol, mercury bichloride or alkaline coal tar creosotes. Ten per cent sodium bicarbonate will prevent rusting.

(7) *Steam* is satisfactory, reliable, quick and penetrating. It sterilizes, but shrinks woolens and injures silks. It ruins leather, furs, skins of all kinds, rubber shoes, oilcloth and articles containing rubber, glue, varnish or wood.

GASEOUS DISINFECTION

Terminal fumigation was formerly practiced following al most every communicable disease but of late this practice has been largely discontinued. In most diseases the thorough airing and sunning of the room and the disinfection of all articles which have come in contact with the patient are sufficient. There has been a false sense of security in fumigation and it has too frequently been carelessly carried out while the more important disinfection of contaminated material has been neglected. Many health departments continue to fumigate after smallpox, scarlet fever and diphtheria, but even this is likely to be abandoned. If it is done it should be certain that the room is made tight by pasting paper over cracks and holes and that the gases or fumes are liberated in proper quantity and given the proper time for action, under suitable conditions of temperature and moisture. Fumigation will always be continued to kill animals which carry the germs of infectious disease. Whether rooms are fumigated or not they should always be renovated, cleaned and aired after a case of infectious disease. Continuous and terminal disinfection of contaminated material should never be neglected.

Formaldehyde Gas.—Formaldehyde is the most generally applicable gas for this type of disinfection. Neither this nor any other gas has great power of penetration and its use must be limited to surface disinfection. It is highly irritating but not poisonous to man and does not injure fabrics, colors, metals or paintings. Its specific gravity is about that of the air and it diffuses slowly. It is not an insecticide. It combines with decomposing nitrogenous substances and deodorizes them. It *may* kill spores and dry organisms.

Formalin as it is purchased in the market is a 40 per cent solution of formaldehyde gas in water. At 20° C. the gas polymerizes and forms trioxymethylene, a white crystalline substance.

There are two methods of liberating or driving off formaldehyde gas by the heat liberated from chemical reactions.

In the *Permanganate-Formalin Method* 25 grams of $KMnO_4$ are added to 500 c.c. of formalin for every 1000 cubic feet of air space.

In the *Formalin-Lime-Aluminum-Sulphate Method* two solutions are used. Solution A contains 150 grams of aluminum sulphate dissolved in hot water (300 c.c.). Solution B contains 600 c.c. of formalin. Solutions one and two are mixed and poured upon 2000 grams of unslaked lime. These quantities give the proper amount of gas for 1000 cubic feet of air space.

Exposure should be from six to twelve hours for disinfection with the air at a temperature of 65° F. and at least 60 per cent saturated with moisture.

Besides these methods of liberating formaldehyde gas there are other ways of disinfecting with it, viz.: (1) the autoclave under pressure, (2) the retort without pressure, (3) a generator or lamp, (4) formaldehyde and dry heat in partial vacuum, (5) spraying formalin, (6) heating paraform.

Sulphur Dioxide.—The gas SO_2 depends upon a combination with water and the formation of sulphurous acid (H_2SO_3) for its disinfecting action. Its efficiency, therefore,

depends upon the moisture present in the air. It is heavier than air and readily soluble in water. It does not penetrate nor does it kill spores.

The methods of fumigating with SO_2 include: (1) The Pot Method by which sulphur is burned in a metal dish, (2) The Liquid Sulphur Dioxide Method in which liquid SO_2 purchased in tubes is allowed to evaporate, (3) The sulphur Furnace method by which the fumes are poured into the room or space to be fumigated.

Five pounds of sulphur per 1000 cubic feet of room space are required for germicidal action; 2 lbs. per 1000 cubic feet of room space are required for insecticidal action. One pound of sulphur is the equivalent of 2 lbs. of liquid SO_2.

This gas is used primarily as an *insecticide* and in such capacity needs no moisture. When so used in a house moisture should be avoided as in the presence of water it rots fabrics, injures paintings and metallic fixtures, and bleaches pigment. The reaction time ranges from 6 to 12 hours.

Oxygen in its nascent state is a good disinfectant. It kills by combining chemically with the albuminous matter of the bacterial cell.

Hydrocyanic Acid is dangerous because it is so deadly a *poison for man.* It is a good insecticide but not a good germicide. It is not toxic to plants, but is particularly toxic to animals. It does not destroy paintings, furniture, draperies or carpets. It is slightly lighter than air, invisible, and has the odor of bitter almonds.

It is evolved by the action of H_2SO_4 on KCN: ($1\frac{1}{2}$ parts H_2SO_4, and $2\frac{1}{4}$ parts H_2O, to 1 part KCN). Mix the water and acid together then add potassium cyanide. Use 4 ounces to 5 ounces of KCN per 1000 cubic feet. Sometimes SO_2 is used with HCN because the odor of the sulphur will give warning of the more deadly gas. It is most used to rid isolated buildings and ships of vermin.

LIQUID DISINFECTANTS

Disinfecting *solutions* have great powers of penetration, whereas, *emulsions* do not penetrate but have a high germicidal action on a surface where the suspended material of the emulsion accumulates.

Mercuric Chloride ($HgCl_2$) is a valuable germicide, destructive to all microbial life in weak solutions. It kills both germs and spores but does not deodorize. It is highly poisonous. It corrodes metals and forms insoluble and inert compounds with albuminous matter.

$HgCl_2$ is a white, volatile and crystalline substance, dissolving in 16 parts of cold water and 3 parts of boiling water. It is highly soluble in alcohol. HCl, NaCl, and NH_4Cl aid in its solution. It is decomposed by lead, copper and other metals. It is used in dilutions of 1:500 or 1:1000. A solution of 1:1000 kills vegetative cells in ½ hour. A 1:500 dilution kills spores in 1 hour. A 1:1000 solution = 1 gm. per liter or 1 dram per gal.

Formalin is a forty per cent solution of formaldehyde gas in water. It acts well in the presence of albuminous matter and is not injurious to most articles. It is a true deodorant and not very poisonous to man although it is unstable and polymerizes in cold weather to form trioxymethylene. Hot formalin attacks iron and steel but does not attack copper, brass, nickel, or zinc. It has no detrimental effect on fibers and does not bleach colors but it renders leather and furs brittle. A ten per cent solution of formaldehyde is equivalent to a 1 to 500 solution of $HgCl_2$ and superior to 5 per cent phenol. Feces are deodorized (and disinfected when thoroughly mixed) by 10 per cent formalin.

Potassium Permanganate ($KMnO_4$) has limited application since it is readily reduced by organic matter but it is a good germicide in surgical practice. It is a dark purple, crystalline substance and has a sweet astringent taste. Probably free nascent oxygen is the true disinfecting agent. It kills vegeta-

tive organisms and spores. It is soluble in 16 parts cold water and 2 parts boiling water.

Lime is one of the best and cheapest disinfectants we have. It is used as slaked lime or as chlorinated lime for destroying infection in organic matter. CaO is obtained by calcinating or heating native $CaCO_3$ (chalk, limestone, or marble). The addition of water to calcinated lime produces slaked lime which may be used for germicidal purposes. *Slaked lime* [$Ca(OH)_2$] is a mixture of one pint of water for every 2 lbs. of calcinated lime. Lime absorbs about one-half its weight of water. Freshly slaked lime should be used, else CO_2 is absorbed from the air, and the slaked lime becomes inert $CaCO_3$.

Whitewash is slaked lime diluted with ten parts of water and mixed with glue. It is valuable for destroying spore free bacteria that have lodged on the surfaces of rooms, barns, stables, etc.

Milk of Lime is slaked lime diluted with about 4 times its volume of water to a thick creamy consistency. It is useful for the disinfection of excreta and privy vaults. Freshly slaked lime must be used in its preparation. If older than a few days it is probably worthless.

Ten per cent $Ca(OH)_2$ solution kills vegetative germs in a few hours; a 3 per cent $Ca(OH)_2$ solution kills typhoid germs in one hour; a 20 per cent $Ca(OH)_2$ solution will sterilize feces in one hour.

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INDEX

A

Abnormalities, inherited, 121
Accident insurance, 342
  prevention, 346
Acne, 98
Actinomycosis, 188, 374, 381
Action, hygiene of, 80
Activated sludge, 272
Acute infectious conjunctivitis, 374, 381
Adenoids, 62
Administration, local health, 300
  of health in industry, 343
  of school health, 306
  of state health, 295
Adulteration of food, 232
Aerial blanket, 359
Aerobic purification of sewage, 268
African sleeping sickness, 187
Agglutinins, 202
Air cooling, 371
  odors in, 362
  physical properties of, 360
  washing and humidifying, 370
Alcohol, 111, 112
Alimentary diseases, 178
Alveolar process, 57
Amboceptor, 204
Anaerobic purification of sewage, 272
Anaphylaxis, 199
Ankylostomiasis, 374, 382
Animal parasites, 99
Ankylosis, 61
Anthrax, 188, 374, 383
  immunity in, 159
Antiseptics, 379, 421, 422
Antitoxin, 161, 201
Arteriosclerosis, 144
Artificial ventilation, 367
Asepsis, 421
Assimilation, 50
Asthma, 151
Astigmatism, 322
Audiometer, 324
Autointoxication, 51
Autonomic nervous system, 49

B

Bacillary dysentery, 375, 389
Bacteriophage, 209
Balanced diet, 40
Barbers' itch, 99
Bathing, hygiene of, 94
Behring and Kitasato, 161
Benzene poisoning, 356
Beriberi, 37
Blood vessels, diseases of, 144
Bodily activities, 80, 85
  defects, 110
Body louse, 187
  wastes, elimination of, 51
Boils, 98
Botulism, 244
Breast feeding, 134
Breathing, 91
Bright's disease, 147
Broad Street well, 164

C

Calcium, 35
Cancer, 145
Calories, 41
Cannon, Walter D., 44
Carbohydrates, 33
Caries, 67
Carriers of disease, 196, 378
Central nervous system, function of, 101
Cerebrospinal meningitis, 374
Cesspool, 273, 280
Chemical closet, 267
Chickenpox, 375, 385
Child health center, 170
  labor, 341
"Child's Ten Commandments to Parents," 139
Chlorination of water, 263
Cholera, 164, 375, 385
Chromosomes in inheritance, 119
Clothing, hygiene of, 95
Coca cola, 112
Coffee, 112
Colds, cause of, 228
Color blindness, 120, 123
Cooling air, 371

Comfort meter, 365
Common law, 293
Communicable diseases, 152, 175
carriers of, 378
control of, 311, 374, 377
definitions, 374
definitions of terms applied in, 378
Community health centers, 171
Complement, 204
Concentration, mental, 102
Conduct and heredity, 127
Conjunctivitis, acute infectious, 374, 381
Conn, H. W., 167
Constipation, 53
Contact diseases, 188
Corns and warts, 98
County health unit, 302

D

Dairy score card, 238, 239
Decalogue of health, 333
Defective hearing, 322
vision, 319
Defects, physical, 110, 194
of school children, 312
Definition of terms, 378
Deforming habits, 62
Deformities of feet, 88
of teeth, 61
D'Herelle, 209
Dengue, 185, 375, 387
Dental care of school children, 324
floss, 75
hygiene, 56
hygienist, 72, 310
Delousing, 379
Dentistry, industrial, 352
Deodorants, 421, 422
Diabetes, 147
Diet, 31
and tooth decay, 69, 79
balanced, 40
varied, 43
Digestion, 43
Diphtheria, 161, 375, 387
Disease and fermentation, 154
alimentary, 178
carriers of, 196, 378
contact, 188
early theories of, 152
heart, 143
industrial, 353
Disease—Cont'd
inherited, 121
inoculation, 180
insect-borne, 182, 187
mosquito-borne, 182
organisms of, 177
prevention of, 309, 353
respiratory, 187
science of prevention, 152
Diseases of blood vessels, 144
venereal, 226
Disinfecting, 379
Disinfection, 379, 421, 422
final, of sewage, 274
gaseous, 425
liquid, 428
natural, 423
physical agents of, 424
standardizing of, 423
Disorders of the skin, 96
Disposal of garbage, 281
of manure, 284
of sewage, 265
Dreams, 106
Drugs, 194
Dysentery (amebic), 375, 389
Dysentery (bacillary), 375, 389

E

Earache, 91
Ehrlich, theories of immunity, 206
Eliminating body wastes, 51
Emotions and digestion, 44
hygiene of, 47, 109
Endocarditis, 143
Endocrine disorders, 148
Endotoxins, 198
Energy requirements, 41
Enzymes, 44
Epidemic encephalitis, 375, 390
of Broad Street well, 164
typhoid from oysters, 167
Ergosterol, 40
Erysipelas, 189
Eugenics (*see* Heredity)
Exercises, 80
effects of, 81
rhythm in, 84
types of, 83
Exotoxins, 198
Exposure to wet and cold, 194
Eye infections, 90
strain, 110
Eyes, care of, 90

F

Factory and inspection, 342
Fatigue and immunity, 193
  in industry, 340
Fats, 34
Favus, 375, 391
Federal health functions, 285
Feeble-mindedness, 126
Feet, deformities of, 88
Fermentation and disease, 154
Filtration of sewage, 270
  of water, 262
Flea, 187
Fly breeding, prevention of, 284
Fones, Alfred C., 324
Food, adulteration of, 232
  control, 232
  drug act, 235
  establishments' score card, 246
  in industry, 348
  laws, 233
  poisoning, 53
  sanitation, 236
Foot and mouth disease, 188
Formaldehyde, 426
Formalin, 428
Frank, Glenn, 170
Fumigation, 379, 422

G

Garbage, disposal of, 281
Gaseous disinfection, 425
German measles, 375, 391
Germicide, 421
Gingivae, 70
Glanders, 188, 375, 392
Glycogen, 34
Goddard, Henry, 126
Goiter, 149
Gonorrhea, 375, 393
Ground water, 250

H

Habits, 103
  and health, 20
  deforming, 62
Hay fever, 150
Headaches, 90
Health centers, 170, 171
  decalogue of, 333
  defined, 20
  education, 332
  maintenance, 142
  officer, training of, 303
Health—Cont'd
  oral, 56
  personality and, 25
  scale, 23
  score card for, 26
  services, 173
  societies, 304
  training program, 334
  values, 18
Hearing, 90
  defective, 322
  tests, 323
Heart disease, 143
Heredity, 113
  and conduct, 127
  and disease, 121
  and environment, 125
  and mentality, 123
Hippocrates, 152
Hookworm, 374, 382
Hormones, 148
Humidifying air, 370
Hydrocyanic acid, 427
Hygiene, industrial, 337
  ocular, 90, 319, 373
  of action, 80
  of central nervous system, 101
  of the ears, 91
  of the emotions, 47
  of the eyes, 90
  of the mouth, 56
  of nutrition, 30
  of reproduction, 113
  preventive, 169
  school, 305
  sex, 138
Hygienist, the dental, 72, 310
Hygrodeik, 364
Hypertension, 144

I

Immunity, acquired, 195
  active and passive, 196
  against diphtheria, 163
  and exposure, 194
  and fatigue, 193
  defined, 191
  drugs, 194
  essential facts of, 191
  in anthrax and rabies, 159
  local, 195
  malnutrition and, 194
  natural, 195
  non-specific, 193

Immunity—Cont'd
specific, 195
theories of, 204
Imhoff tank, 273, 280
Impetigo, 375
Indigestion, emotional, 46
Industrial accident insurance, 342
accident prevention, 346
dentistry, 352
diseases, 353
employment of women, 341
fatigue, 340
food control, 348
poisons, 354-357
Industrial hygiene, 337
administration of, 343
child labor and, 341
factory inspection and, 342
medical activities of, 349
sanitation, 348
Infant care, 129, 133
mortality, 137
Influenza, 375, 394
Inherited diseases and abnormalities, 121
Injunction, 294
Inoculation diseases, 180
Inorganic salts, 35
Insect-borne diseases, 187
Intermittent sand filtration. 270
Interrelationship of plants and animals, 175
Iodine deficiency, 149
Iron, 35
Isolation, 380

J

Jenner, 158

K

Kallikak family, 126
Kitasato and Behring, 161
Klebs-Loeffler bacillus, 161
Koch, 156

L

Lawrence experiment station, 270
Laws, public health, 292
pure food, 233
Lead poisoning, 351
Leprosy, 375, 395
Levine and Warthin, 146
License, 293
Lighting, 372
Lime, 429
milk of, 429
Lister, 156
Local health administration, 300
Lockjaw, 189, 376, 411
Louse, 187
Lysins, 203

M

Malaria, 183, 375, 396
Malnutrition, 194
Malta fever, 375, 397
Manson, Sir Patrick, 181
Manure, disposal of, 284
Mastication, 48, 66
Maternal death rate, 131
Maternity care, standards of, 131
Measles, 375, 398
German, 375
Meat, diseases transmitted by, 244
inspection, 243
Mechanical filter, 262
ventilation, 367
Mendelian inheritance in man, 121
Mendel's law, 113
Meningitis, cerebrospinal, 374
meningococcus, 375, 399
Mental examination, 317
Mentality and heredity, 123
Mercuric chloride, 428
Mercury poisoning, 356
Metchnikoff, 198, 205
Midwives, 132
Miles's process of sewage purification, 267
Milk, 236
condensed, evaporated and dried, 243
cow's, composition of, 41
grading of, 241
human, composition of, 40
inspection, 242
pasteurization of, 240, 241
remade, 242
sanitation of, 236
Milk of lime, 429
Modern health services. 170
Moisture in air, 361, 369
Mole, 98
Mortality, maternal, 131
Mosquito-borne diseases, 182
Mosquitoes, control of, 185
Mouth hygiene, 56
washes, 76

Mucus, 66
Mumps, 376, 401
Myocarditis, 143

N

Natural disinfection, 423
  ventilation, 366
Nephritis, 147
Nervous system, hygiene of, 101
Neurasthenia, 108
Nitrogen cycle, 253, 254
Nitrogenous foods, 33
Nutrition, 30

O

Obesity, 53
Ocular hygiene, 90, 319, 373
Odors in air, 362
Opsonins, 199
Oral prophylaxis, 67
Organized health services, 173
Overwork, 108
Oxidation, 50

P

Parasites, 99
Paratyphoid fever, 376, 401
Pasteur, 155, 159
  treatment, 160
Pasteurization, 240
Patent medicines, 112
Pawlow, 44, 50
Pay clinic, 172
Pediculosis, 100
Pellagra, 37
Permits, 294
Personal hygiene, division of, 30
Phagocytosis, 198
Phosphorus poisoning, 355
Physical defects, 194
  education in school, health programs, 335
  examination, in industry, 339
    in schools, 312
Pit privy, 278
Plague, 187, 376, 403
Plagues, three great, 212
Pneumonia, 376, 404
Poisoning, industrial, 354-357
  ptomaine, 245
Police power, 293
Poliomyelitis, 376, 405
Polymeter, 365
Posture, 85
Potassium in diet, 35
Potassium permanganate, 428
Precipitins, 202
Pregnancy, 130
Prenatal care, 129
Preschool child, care of, 136
Preventive hygiene, 169, 174
  medicine, 158, 174
  sanitation, 163, 174
Privies, sanitary, 278, 279
Prophylaxis, oral, 67, 71
Proteins in diet, 34
Psychrometer, 364
Ptomaine poisoning, 245
Ptyalin, 66
Public health, administration of, 285
    commissioner, 296
    council, 296
    county units, 302
    federal agencies of, 285, 291
    laws, 292
    local organization for, 300, 301
    powers of federal government, 286
    state administration of, 295
    unofficial agencies of, 303
Pure food laws, 233

Q

Quarantine, 380

R

Rabies, 189, 376, 406
  immunity in, 159
Rat flea, 187
Receptacle privy, 279
Relapsing fever, 187
Relative humidity, 363
Renovation, 380
Reproduction, hygiene of, 113
  vitamins, associated with, 40
Resistance to disease, 169
Respiratory diseases, 187
Rest, after eating, 50
  and nutrition classes, 329
Rickets, 39
Rideal-Walker test, 424
Ringworm, 98
Rocky Mountain spotted fever, 187, 376, 406
Round shoulders, 85
Rural sanitation, 277-284

S

Saliva, 65
Sand filtration of water, 262
  of sewage, 270
Sanitation, rural, 277-284
Scabies, 99, 189, 376
Scarlet fever, 376, 407
Schick test for diphtheria, 162
School health program, 306
    correction of defects, 318, 328
    communicable disease control in, 311, 374, 377
    dental service in, 324
    physical education in, 335
    standards of, 335
  education, 332
  promotion, 330
    mental examinations, 316
    personnel for, 310
    physical examination, 312
    special health classes, 329
  training program, 334
 hygiene, 305
  medical service in, 326
 sanitation, 308
Score card, dairy, 238, 239
  food establishment, 246
  health, 23, 26
Scurvy, 38
Sedgwick-Rafter process, 257
Self-purification of streams, 258
Sepsis, 421
Septic sore throat, 376, 408
 tank, 273
 teeth, 78
Serum sickness, 200
Sewage, anaerobic purification of, 272
 bacteriologic purification, 268
 chemical purification of, 266
 direct disposal of, 266
 disposal in rural areas, 277
 farming, 268
 final disinfection of, 274
 limitations of purification, 275
 purification, methods and costs, 276
Sex education, 138
 how determined in offspring, 119
 hygiene of, 138
Sex-cell, 115
Sex-linked characters, 120
Side chain theory, 205
Sight and hearing, 90
Skin, disorders of, 96
  section of, 97
  tests, 150, 151
Sleep, 103
Sling psychrometer, 363, 364
Sludge, activated, 272
Slye, Maude, 145
Smallpox, 376, 409
  vaccination for, 158
Smith, D. D., 71
Societies, health, 304
Speaking, hygiene of, 93
Spinal curvatures, 88
Special health classes, 329
Sprinkling filters, 271
Standards, infant care, 137
  maternity care, 131
  preschool child, 137
  school children, 335
Starches in diet, 33
State department of health, 295
Statutory law, 293
Sterilization, 421
Stimulants, 111
Storage of water, 258
Subsurface irrigation, 281
Sugar in diet, 34
Sulphur dioxide, 426
Sunday observance, 107
Sydenham, 152
Syphilis, 221, 376, 410
  immunity of, 224
  prevention of, 224
  transmission of, 223

T

Tank, Imhoff, 273, 280
  septic, 273,
Tapeworms, 245
Tea, 112
Teeth, care of the brush, 74
  care of children's, 77
  cleansing food for, 77
  daily care of, 73
  decay of, 67, 69
  development of, 56, 58
  diet in relation to decay, 69
  form and arrangement of, 56
  function of, 59
  in relation to digestion, 43
    to infection, 56
  prophylactic treatment, 71
  septic, 78

Teeth—Cont'd
structure of, 63
the method of brushing, 73
Temperature and ventilation, 360
Tests for hearing, 323
Tetanus, 189, 376, 411
Texas fever, 187
Theories of disease, 152
of immunity, 204
Thermometer, wet bulb, 362
Thumb sucking, 63
Tick, 187
Toothpicks, 75
Tooth pastes, 76
Tooth powders, 76
Toxins, 197
Trachoma, 90, 188, 376, 412
Trichina spiralis, 244
Trichinosis, 244, 376, 413
Trickling filters, 281
Tsetse fly, 187
Tuberculosis, 213, 220, 377, 414, 415
difficulties in control of, 215
in industry, 353
prevention and control of, 218
child type, 220
transmission of, 216
Tularemia, 377, 415
Twins, 118
Typhoid fever, 377, 416
from oysters, 167
Typhus fever, 187, 377, 418

U

Under-eating, 54
Unit factors, 113
U. S. Public Health Service, 288

V

Vaccination, development of, 158
Vaccine, bacterial, 195
Calmette-Guerin, 215
mixed, 196
polyvalent, 196
sensitized, 196
Vectors of disease, 181
Venereal diseases, 188, 226
Ventilation, artificial or mechanical, 367
economical value of, 371
heating and, 365
natural, 366
quality of, 358
Virus, 195
Vision, defective, 319
Vital statistics, 297
Vitamins, 36-40
antineuritic, 37
antirachitic, 39

W

Walking, 84
Warthin, 146
Warts, 98
Water, analysis of, 252
bacteriology of, 252
characteristics of good supply, 249
chemical tests of, 253
chlorination of, 263
emergency treatment of, 264
filtration of, 262
ground, 250
in diet, 32
microscopic analysis of, 257
physical tests of, 253
purification of, 258
storage of, 258
surface, 250
with meals, 48
Whitewash, 429
Whooping cough, 377, 418
Women in industry, 341
Wood, Dr. Thomas D., 23
Woods, F. A., 124
Work, change of, 107

X

Xerophthalmia, 36

Y

Yellow fever, 184, 377, 419

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